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State of Connecticut

REPORT

OF

The Connecticut Agricultural
Experiment Station

FOR THE YEAR 1906

PART IV

SIXTH REPORT OF THE STATE ENTOMOLOGIST

W. E. BRITTON, Ph.D.

SIXTH REPORT
OF THE
STATE ENTOMOLOGIST
OF
CONNECTICUT
FOR THE YEAR 1906

BY
W. E. BRITTON, PH.D.
State Entomologist

New Haven, Conn.

1907

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ILLUSTRATIONS.

Figure 1 is from a drawing by B. H. Walden: 2 from a published map adapted by W. E. Britton: 13 from a drawing by W. E. Britton: 3—7 are from the report for 1905: 8—12 from the Bureau of Entomology, U. S. Department of Agriculture.

The map facing page 236 was prepared in the office of Mr. A. William Sperry, civil engineer, New Haven.

The plates are all from photographs, as follows:—

Plates VIII, a and b, and XV, a and c, by W. E. Britton; XII, by D. B. Pangburn; XVI, a, by H. A. Doty; XI, from four negatives taken by Messrs. Britton, Walden and Pangburn; all others by B. H. Walden.

Plates, XV, c, and XVI, a, have appeared in previous reports.

PART IV.

SIXTH REPORT

OF THE

STATE ENTOMOLOGIST OF CONNECTICUT

To the Director and Board of Control of the Connecticut Agricultural Experiment Station:

In accordance with the provision made in Section 4387 of the General Statutes, I herewith transmit my sixth consecutive report as state entomologist. The financial statement corresponds with the State fiscal year ending September 30th, but otherwise the report covers the calendar year of 1906.

Respectfully submitted,

W. E. BRITTON,

State Entomologist.

REPORT OF THE RECEIPTS AND EXPENDITURES OF THE STATE ENTOMOLOGIST FROM OCTOBER 1ST, 1905, TO SEPTEMBER 30TH, 1906.

Receipts.

From E. H. Jenkins, Treasurer	\$2,912.41
Conn. Agr. Expt. Station, for assistance.....	1.75
Yale Forest School, insect cases.....	2.50
Various sources, for mileage.....	6.18
" " " stamps	.57
Conn. Board of Agriculture, for gypsy moth work	800.00
	\$3,723.41

Expenditures.

Field, office and laboratory assistance.....	\$1,283.53
Printing and illustrations	54.70
Postage	19.66
Stationery	53.90

Telephone and Telegraph	\$ 4.33	
Express, freight and cartage.....	19.48	
Library	140.25	
Laboratory apparatus and supplies.....	164.04	
Spraying apparatus and supplies.....	21.64	
Office supplies	99.78	
Traveling expenses	290.26	
Gypsy moth work	1,553.31	
Balance, cash on hand.....	18.53	
		\$3,723.41

Memorandum—This account of the state entomologist has been duly audited by the State Auditors of Public Accounts.

It has seemed best in the foregoing statement to place all expenditures incurred on account of the gypsy moth work under that head. A portion of this, of course, was for traveling expenses, for assistance and labor, for printing, for carting and for apparatus.

ORGANIZATION AND EQUIPMENT.

The state entomologist has been assisted throughout the year, as in the past four years, by Mr. B. H. Walden, who has had charge of all work in the absence of the entomologist. Mr. Walden has done much of the field work, has had charge of the collection, and has done most of the photographic work. He has also aided in the preparation of this report. Miss Elizabeth B. Whittlesey has worked as stenographer for half of each day, as during last year.

On account of the gypsy moth work at Stonington, additional assistance became necessary and Mr. James A. Hyslop, a student in the Agricultural College at Amherst, Mass., had immediate supervision of the field work from July 1st to September 1st, and assisted one week in inspecting nurseries.

Messrs. J. H. Cleveland and Robert Carson of Stonington, C. H. Pangburn, D. B. Pangburn and P. L. Buttrick of New Haven, and G. R. J. Boggs of Cambridge, Mass., were employed at Stonington in banding trees and destroying caterpillars during the caterpillar season. D. B. Pangburn and Mr. Buttrick worked at the laboratory during August, the former on photographic work and the latter mounting insects and preparing life history sets for exhibition. Mr. G. H. Hollister, a graduate of the Connecticut Agricultural College at Storrs, began

work November 16th as foreman in charge of a gang of men at Stonington, cutting brush and scouting for egg-masses.

There has been no material change in equipment since my last report. Four metal cases and over one hundred Schmitt boxes have been purchased. The collection has been increased, especially by quite a lot of material captured at Stonington, this section of the state not being previously represented; and by about five hundred specimens, mostly moths, collected at Pemaquid Point, Maine, in August, by Prof. H. W. Foote of Yale University, and presented by him to the station.

Several books and separates have also been added to the department library.

PUBLICATIONS FROM ENTOMOLOGICAL DEPARTMENT.

Bulletin No. 153. The Gypsy Moth and the Brown-Tail Moth, by W. E. Britton; 11 pages, 8 figures. Published in an edition of 10,000 copies and distributed in March.

Fifth Report of the State Entomologist (Part IV of the Station Report for 1905); 75 pages, 7 text-figures, xii plates. 9,000 copies, distributed in May.

Placard giving illustrations and brief description of the gypsy moth. 2,000 copies, May, distributed to schools and libraries.

San José Scale; Methods of Treatment in Connecticut. *National Nurseryman*, March, 1906.

Some New or Little-Known Aleyrodidae of Connecticut, II, by W. E. Britton. *Entomological News*, Vol. XVII, p. 127. 3 pages.

The Common House Fly in its Relation to the Public Health, by W. E. Britton. A paper read at a conference of health officers, New Haven, Dec. 8, 1905, and printed in the *Yale Medical Journal* for January, 1906.

"Tests of Lime-Sulphur Washes in Connecticut in 1905." "Destroying the Woolly Maple Leaf Scale by Spraying." Two short papers by W. E. Britton, read at the meeting of the Association of Economic Entomologists at New Orleans, Jan. 1st, 1906, and printed in the proceedings. Bulletin No. 60, Bureau of Entomology, U. S. Department of Agriculture.

Bulletin of Immediate Information No. 3. The Fumigation and Treatment of Nursery Stock, by W. E. Britton; 8 pages, 5 figures. Printed in an edition of 1,000 copies, and sent to nurserymen in November.

The Maple Leaf-Stem Borer or Sawfly (*Priophorus acericaulis* MacGillivray). A New Enemy of the Sugar Maple, by W. E. Britton. *Entomological News*, Vol. XVII, p. 313, November; 9 pages, 3 figures, 1 plate.

CHIEF LINES OF WORK.

The general routine work of the office, such as inspecting the nurseries, examining orchards, gardens and greenhouses, identifying insects and answering letters, has taken more than the usual amount of time this season on account of the gypsy moth work, which has necessitated much correspondence, and induced people to send specimens. Then, too, the condition of the nurseries was such that considerably more time than usual was consumed in the inspection work.

Suppression work against the gypsy moth was carried on continuously from March until September, though men were not at work all of the time during May. The entomologist visited the infested region once and sometimes twice a week all summer to oversee the work, and Mr. Walden also made frequent trips to look after certain phases of it. This work altogether required more effort and attention than any other single line of work undertaken.

In combating the San José scale, over 600 apple, pear, peach and plum trees were sprayed, mostly with the lime and sulphur mixtures. "Scalecide" was given a trial, with satisfactory results. A few trees were sprayed with "Surekill," but it did not seem to be very effective as a scale destroyer.

The study of tobacco insects was continued, and a paper on this subject appears in this report.

Several experiments were conducted in dipping cabbage, cauliflower and other plants in arsenate of lead mixed in different proportions with water to prevent damage from maggot and cutworms. Some attention was also given to a study of insects attacking cucurbitaceous plants, which, with the cabbages, were grown on a piece of land at Mt. Carmel leased by the station for plant breeding work.

A few tests have been made of different gases for fumigating trees to kill the San José scale, but no report can be given at this time, and the work will be continued.

The study of the insect fauna of Connecticut has been continued, and several notable additions to the collection mark the season's work. Two papers on Orthoptera and Hymenoptera are now being prepared and will soon be published by the Geological and Natural History Survey.

The identity and life history of the maple leaf stem borer has been ascertained and is recorded in another part of this report.

* EXHIBITS.

Exhibits of injurious insects, their work, and the materials and apparatus for controlling them, were made at the annual meeting of the Connecticut Pomological Society at Hartford in February; at the fruit exhibition of the same society in connection with the Horseshoe Park Agricultural Association at its annual fair at Willimantic, September 18, 19 and 20; at Milford grange fair, October 10 and 11; and at the annual meeting of the State Board of Agriculture at New Haven, December 18, 19 and 20.

CORRESPONDENCE.

The work of the office during the year has necessitated the writing of 1,309 letters, and the sending of 172 circular letters and 381 packages by mail and express.

LECTURES.

The state entomologist has given seventeen addresses and lectures at farmers' institutes, grange meetings, village improvement and scientific societies during the year. Two of these were illustrated with lantern slides, and at nearly all of the others photographs and specimens were shown.

EXAMINATION OF ORCHARDS AND GARDENS.

Thirty-four orchards, gardens and greenhouses have been examined for insect pests by the state entomologist or his assistants. In most cases the San José scale or the gypsy moth was feared.

INSPECTION OF NURSERIES.

During the year forty nursery inspections have been made, and thirty-five certificates granted.

In form the certificate has not been changed, nor has there been any change in the law providing for the annual inspection of nurseries. In comparing the list of nurserymen receiv-

ing certificates with the list of 1905, we find about the same number of firms, though four names have been removed from the old list, and five new names appear in the list for 1906. Of those which have been removed from the list one nurseryman has gone out of business, and another has left the state, though his business will be continued by one of the firms new to the present list. Two firms have not been included in the list, and a third has not been given a certificate since the fall inspection, because they have not yet brought their nurseries into such a condition as to warrant the granting of certificates.

More time has been required to make these inspections than in previous years, owing partly to the fact that certain kinds of stock not previously found infested are now attacked by the scale. In making the fall inspections Messrs. Britton and Walden were busy most of the time during the months of September and October when weather permitted. The equivalent of one man working sixty-three entire days was the time actually consumed in making these inspections.

The nursery firms receiving certificates in 1906 were as follows:

LIST OF NURSERY FIRMS RECEIVING CERTIFICATES IN 1906.

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Allen, Chas. I.	Terryville	Nov. 2,	235
Atwater, C. W.	Collinsville	Sept. 18,	215
Austin, Geo. W.	New Haven	Nov. 3,	238
Barnes Bros. Nursery Co.	Yalesville	Oct. 16,	226
Bowditch, J. H.	Pomfret Center ..	Sept. 10,	212
Brainard, Chester F.	Thompsonville...	Oct. 8,	221
Bridgeport Nursery Co.	Bridgeport	Nov. 2,	237
Burr & Co., C. R.	Manchester	Oct. 8,	226
Comstock & Lyon	Norwalk	Oct. 29,	233
Conine Nursery Co., The F. E.	Stratford	Oct. 4,	216
Conn. Agricultural College....	Storrs	Nov. 1,	234
Conway, W. B.	New Haven	Nov. 13,	243
Dehn & Bertolf,	Greenwich	Oct. 18,	228
East Rock Park Nursery	New Haven	Nov. 7,	240
Elizabeth Park Nursery	Hartford	Dec. 31,	244
Elm City Nursery Co.	New Haven	Sept. 6,	211
Gurney & Co., H. H.	New Canaan	Oct. 4,	218
Hale, J. H.	So. Glastonbury..	Nov. 6,	239

Name of Firm.	Location.	Inspection Finished.	Certificate Number.
Holcomb, Irving	Granby	Sept. 28,	214
Hoyt's Sons Co., Stephen	New Canaan	Oct. 5,	219
Hunt & Co., W. W.	Hartford	Oct. 8,	222
Jewell, Harvey	Cromwell	Oct. 9,	225
Kellner, H. H.	Danbury	Oct. 15,	227
Kelsey & Sons, David S.	West Hartford	Nov. 2,	236
Keney Park Nursery	Hartford	Dec. 31,	245
Norton, A. F.	New Britain	Oct. 17,	229
Oakland Nurseries	Manchester	Oct. 4,	217
Pierson, A. N.	Cromwell	Sept. 22,	213
Purinton, C. O.	Hartford	May 1,	210
Ryther, O. E.	Norwich	Oct. 27,	232
Scott, J. W.	Hartford	Oct. 23,	230
Sierman, C. H.	Hartford	Oct. 24,	231
Vidbourne & Co., J.	Hartford	Oct. 8,	223
Woodruff, C. V.	Orange	Nov. 8,	241
Woodruff & Sons, S. D.	Orange	Nov. 8,	242

PRESENT AREA OF CONNECTICUT NURSERIES.

According to the statement of owners, supplemented in some cases by the estimate of the inspector, there are now 540 acres in Connecticut nurseries as against 422 acres in 1902.

With this increase in area there has been a change in the kind of stock grown: the tendency being to abandon the growing of fruit stock and increase the plantings of ornamental trees and shrubs, especially such as are not seriously injured by the San José scale.

CONDITION OF NURSERIES IN 1906.

I regret to state that we found the nurseries of the state more seriously infested with San José scale in the fall of 1906 than in any year since the annual inspection of nurseries began, in 1901. From what I can learn of the methods of nursery inspection as practiced in other states, I believe that on the whole our system is as thorough and as efficient as that of most other states. All fruit stock and all ornamentals liable to infestation are inspected in such a manner that every tree or shrub is seen by the inspector. If any are found infested, they are marked (trees by breaking, and shrubs with tags), and these are immediately removed from the nursery and destroyed.

All other trees or shrubs in the row or block are fumigated with hydrocyanic acid gas before being sold. Yet in spite of this system, which has been in use since 1901, and the inspection made more and more thorough each year, we found more scale than ever before.

This statement does not apply, however, to every nursery, for some owners have taken the matter in hand and have destroyed or treated their suspected stock, so that the spread of the scale has been checked. In such nurseries conditions have improved. There are even a few nurseries in which the scale was not found at all, nor has ever been found therein; but these are mostly small nurseries not handling fruit stock.

The chief trouble is that nurserymen do not give enough of their own attention to the matter. They rely too much on the work of the inspector, who has to examine a large area of nursery stock in a comparatively short time, and cannot therefore examine the individual trees or plants as thoroughly as he would need to in order to warrant the statement that they are absolutely free from scale. The certificates state that they are "apparently free."

Nurserymen are busy men. They have not found it convenient to take the time to inspect and treat their own stock. Some have great difficulty in obtaining help. Yet so far as the profits of their business are concerned, it would pay better to grow and handle less stock and take better care of it.

It is true that Connecticut is, and for a number of years has been, badly infested with San José scale, but while it may not be possible to grow nursery stock absolutely free from infestation, I am confident that the business can be handled so as not only to hold the scale in check, but to reduce the infestation so materially that the value of the stock destroyed each year will be insignificant. Nurserymen are too careless about propagating from infested trees. Cions, bud sticks and cuttings should all be taken from uninfested trees, even if it be necessary to fumigate growing trees and enclose them in gauze tents or cages to prevent reinfestation. At any rate, all propagating wood should be fumigated with hydrocyanic acid gas to kill any form of animal life which may be there, and no wood known to be infested should be used, even though fumigated.

THE FUMIGATION AND TREATMENT OF NURSERY STOCK.*

There is a sentiment more or less prevalent among orchardists and nurserymen that stock is injured by fumigation with hydrocyanic acid gas, and some refuse to purchase stock which has been so treated, preferring to run the risk of obtaining scale-infested stock thereby. We cannot state that this sentiment is without foundation, because in many cases it is doubtless true that nursery stock has been injured by the treatment, but we have yet to learn of such injury where the work was properly and carefully done and where the stock was well ripened. At the meeting of the Official Horticultural Inspectors at Washington, D. C., November, 1905, the consensus of opinion was that no injury would result if the treatment was properly done. *Trees should not be fumigated when wet, and they should not be fumigated longer than the prescribed period,—half or three-quarters of an hour.*

If the gas is started generating at night and the house not opened until morning, or if the trees are wet when put into the house, we may expect injury. It is well known that a weaker dose for a longer time than is prescribed is both less fatal to the scale and more injurious to the trees. Some injury, especially bruising, results from the extra handling of the trees when fumigated, but it seems probable that injuries of other kinds, such as drying of the roots, or freezing, are often attributed to fumigation.

Since San José scale became such a pest in the eastern states it has been the custom of many official inspectors to advise or compel nurserymen to fumigate certain kinds of nursery stock before sending it out, especially if any infested trees have been found in or near it.

* This paper was printed as Bulletin of Immediate Information No. 3 in a small edition of 1,000 copies, and sent to the nurserymen in November. It is here reproduced with slight changes.

THE FUMIGATING HOUSE.

The house, if small, should be as nearly square as possible, with the generating basin at the bottom near the center, in order to insure the greatest possible uniformity in the distribution of the gas. The house should be gas-tight, with a door

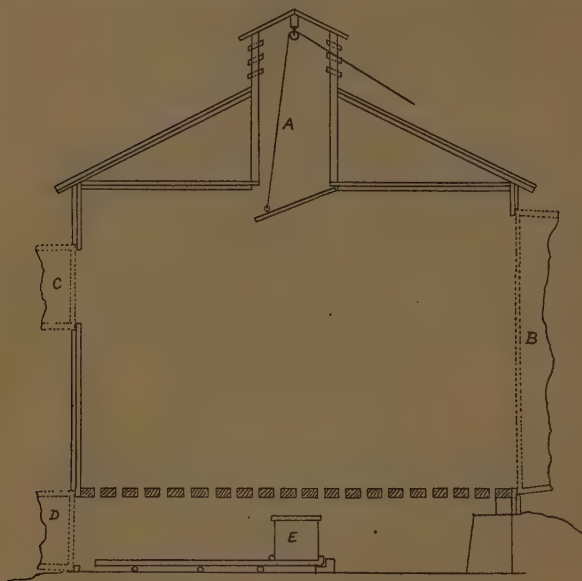


FIG. 1.—Diagram showing cross-section of a fumigating house 10 x 10 x 8 feet in size, with slat floor. A, ventilator that can be opened and closed from the outside; B, door where trees are carried in and out; C, small door opposite large one for ventilation; D, small door for communicating with generator; E, jar for generating the gas.

for transporting the stock, and adequate ventilators manipulated from the outside. A house ten feet square will be found adequate in most nurseries of not more than one hundred acres, and if not large enough, it will often be more convenient to have two of this size than one, larger. At any rate, a small house or box is absolutely necessary in any nursery to save the expense of chemicals in charging the large house when only a few trees or plants are to be treated.

A satisfactory house may be constructed of wood and double-boarded, with building paper between the boards. A slat floor raised a foot or more above the ground, with space for the generator beneath, ensures a more even distribution of the gas and also keeps the trees from contact with the moist earth. The accompanying diagram will give an idea of a good pattern of fumigating house.

Simple contrivances may be used for manipulating the ventilators from the outside and for removing the generating jar and replacing it, as well as for dropping the cyanide into it. All doors and ventilators should be arranged so that the house will be perfectly tight when closed.

DIRECTIONS FOR FUMIGATING.

The space to be fumigated should first be measured carefully, the quantities of chemicals computed, and the figures posted in some place convenient for ready reference. The cyanide for charging the generator a number of times can be weighed out in advance, each lot being placed in a paper or cheese cloth bag ready to be dropped, bag and all, into the acid, but these should be kept dry, in a tight tin box or glass jar, until wanted.

Formula.

The following simple formula for preparing the gas was adopted by the Association of Official Horticultural Inspectors at a meeting in Washington in 1903:—

Quantity for Each 100 Cubic Feet of Space—

- 1 oz. (av.) Potassium cyanide 98-100% purity.
- 2 fluid ozs. High-grade sulphuric acid, 66° B. test.
- 4 " " Water.

A house 10 x 10 x 8 feet, such as is shown in the diagram, contains 800 cubic feet, and for each charge requires:—

- $\frac{1}{2}$ lb. Potassium cyanide.
- 16 fluid ozs. (1 pint) Sulphuric acid.
- 32 " " (1 quart) Water.

Caution! Potassium cyanide is one of the deadliest poisons. Do not let it come in contact with cuts or bruises, nor inhale the dust or fumes which rise from it when it is handled.

Filling the House.

The trees should be placed horizontally upon the slat floor with the roots outside and the tops meeting in the center over the generating jar. Trees or plants may be tied together loosely in bunches, but should not be packed in bales for shipping, as the packing may prevent the gas from reaching the insects, and thus render the operation valueless.

Generating the Gas.

For a small house like that described, a single jar in the center will suffice. If much larger and square, four jars will insure a more even distribution of the gas. If the house is much longer than broad, it is well to have two jars, one under the center of each half of the house. Stone, glass, or earthenware should be used for generating jars. Metal is corroded by the acid, and wood is charred by it.

After the nursery stock has been placed in the house and the ventilators and doors closed, all is in readiness to generate the gas. The water should first be placed in the jar and the acid poured into it in a thin stream with constant stirring in order to prevent too rapid generation of heat. The jar should then be put in place and the cyanide dropped into it. The house should remain closed for at least thirty and not more than forty-five minutes. The overhead ventilator should first be opened, and then the side ventilator and the door. Care must be taken not to breathe the gas, which is one of the most deadly of poisons. The house should be aired for at least ten minutes before allowing any one to enter or remove the trees.

The liquid and residue from the generating jars is poisonous, and should be buried, and not left where children or domestic animals can get at it.

Chemicals.

Much of the cyanide on the market contains, with other impurities, more or less sodium chloride, which decomposes a certain amount of the hydrocyanic acid gas, and is unsatisfactory for fumigating purposes. The Georgia State Board of Entomology collected a number of different brands of cyanide from various dealers and had them analyzed. Only

two brands were sufficiently pure to be reliable for fumigating nursery stock, and nurserymen were recommended to buy these brands, which are—

Merck & Co.'s "98-100%" potassium cyanide.

Baker & Adamson Chem. Co.'s "99%" potassium cyanide.

Both kinds are prepared for chemical use, and may be ordered in advance from any wholesale druggist or dealer in chemicals. The nurserymen should insist on getting one of these brands in the *original sealed packages*, and not be supplied with something else "just as good." The Station has just purchased a five pound package of Merck's cyanide at 35 cents per pound.

A high grade commercial sulphuric acid (66° B.) should be employed. In the large nurseries it will pay to buy acid in carboys, but small quantities can be had in bottles.

FUMIGATE BUDS, CIONS AND CUTTINGS.

The most serious source of infestation of growing nursery stock is through the buds, cions or cuttings. If slightly infested when set, the scales multiply sufficiently to mark the stock by the time it is inspected, or is large enough for sale, consequently much of it must be destroyed on account of scale. Where the scale is introduced on buds, cions or cuttings, the lower portion of the trunk is the first to show the infestation, but if brought by animals, the scale is usually found in the tops of the trees. If allowed to remain untreated in either case, the tree soon becomes coated. All buds, cions and cuttings should therefore be fumigated thoroughly before setting. A small box can be used, and the cost of materials will be much less than if the large fumigating house is charged.

TREATMENT OF GROWING STOCK.

The foregoing directions are applicable only to such nursery stock as may be dug for sale or shipment. Of course, much of the stock cannot be so treated, because it is too small for sale, and if dug and replanted its growth will be greatly checked. Though possible to fumigate growing stock by covering it with gas-tight canvas, the expense is too great,

and spraying must be relied upon to destroy any scale that may be on the trees. Official inspection as commonly practiced is sufficient to detect the infestation unless it be extremely slight, but it is practically impossible on account of the time and expense involved to examine the stock with such care that an absolute statement can be made that it is not infested. Too many nurserymen rely solely upon the official inspector for detecting the scale, and give no inspection themselves or treatment to hold the scale in check, if it be present. It often happens that a few specimens of scale may be overlooked during the annual September inspection or perhaps may be brought to the trees after the inspection. These will multiply until December, and go on spreading the next season, becoming badly covered by fall; and from this source birds, insects or other agencies carry the pest to surrounding stock, necessitating the destruction of a large quantity of it. The scale breeds from June 25th to December 1st in Connecticut, and during this time anything coming in contact with the bark of an infested tree is liable to carry away some of the new-born scales. From a badly infested tree the scales are certain to be distributed along the row by the men and horses in cultivating the field. The owner should inspect his own stock each year not later than July 1st. One tree destroyed then may save a dozen later in the season. The workmen should be familiar with the pest, and whenever an infested tree is discovered it should be taken out.

SPRAY GROWING NURSERY TREES.

Even though we guard against the introduction of the scale by means of buds and cions, it may be brought to the trees by birds and insects during the growing season, especially if in a region where scale is common and the environs are not under direct control of the nurseryman. By spraying the young trees, during the winter or while dormant, with the lime and sulphur wash, "Scalecide," or some other "soluble oil," it is possible to keep the pest in check. "Scalecide" has given satisfactory results, and on account of ease of preparation it is preferable to lime and sulphur. It is especially adapted to nursery purposes, as it leaves no white coating on the trees.

It forms no spots on painted buildings or fences, and is not unpleasant to handle. On the other hand, lime and sulphur possesses fungicidal properties not found in the "soluble oils."

The cost of this spraying should not be more than fifteen or twenty dollars per acre, and the work probably can best be done by men working separately, each fitted with a knapsack sprayer. The spraying should be done when there is no snow on the ground and on a still day.

ENTOMOLOGICAL FEATURES OF 1906.

The very mild winter of 1905-6 seemed especially favorable to most forms of insect life. A smaller percentage than usual of the San José scale was killed by the winter, and hence the pest has spread with greater rapidity than usual through the season.

The maple leaf stem borer, which has been the subject of study for several years, proved to be a sawfly, and adults were secured for the first time in 1906. This interesting insect is not yet to be considered as an important pest, yet it is spreading, and in certain places and under certain conditions is capable of doing much harm. An article on p. 295 gives a brief account of it.

The most important feature of the season was the discovery of the gypsy moth at Stonington. A female moth was captured in 1905 by Mr. Frensch, who put it in his collection and forgot about it, but finally reported it to the state entomologist in February, 1906, after receiving a request for records of rare captures. A more complete account of this discovery was given in the Report for 1905, p. 246.

The warning regarding this insect was sent out in Bulletin No. 153, and was printed in newspapers throughout the state. Consequently people were watching for this pest, and observed other kinds of insects. Many caterpillars were received from persons who were anxious to learn if they were the gypsy caterpillars. As yet we have no record of the presence of the brown-tail moth in Connecticut. The spiny elm caterpillar (*Euvanesa antiopa* Linn.) was very common, and was sent to the station twenty-six times, from all parts of the state, and in many cases this species was mistaken for the gypsy caterpillar.

The spiny elm caterpillar is the subject of a separate article on p. 260 of this report.

As in 1905, much damage was caused by cutworms in gardens and fields. Potato beetles were more abundant in most parts of the state than for three years. Aphids were abundant and injurious. The apple aphid (*Aphis pomi* DeG.) did much damage in some of the nurseries and newly-set orchards. In several nurseries it was necessary to dip the upper twigs into kerosene emulsion or soap and water to kill the aphids, so that growth would not be too greatly checked.

In August Mr. Walden visited a large seed storehouse in Milford and found the grain infested by an insect not commonly found in such places, though its work is very similar to that of the Indian meal moth described in the Report for 1905. Specimens were sent to the Bureau of Entomology of the U. S. Department of Agriculture at Washington, and it was identified as the European grain moth, *Tinea granella* L. This is the first record of this insect for Connecticut, and Dr. Howard writes that the same species had been received from Canada and from Michigan during the year. Previous to this it was not known with certainty to occur in America.

During the winter my attention was called by Prof. L. V. Pirsson of the Sheffield Scientific School of Yale University to an infestation of Kirtland Hall by the "powderpost" beetle (*Lyctus unipunctatus* Hbst. = *striatus*). The building was finished in ash, and had been occupied only about a year. Many of the casings, shelves, drawers, desks and cabinets were infested, some pieces of wood being drilled full of holes. Sap wood was used somewhat in finishing the building, and this was the worst infested. Benzine was suggested as a remedy, and I afterward learned that it had been used with good results.

In late summer the leaves of chestnut trees turned brown from the attacks of a mite, closely allied to the red spider. Egg-shells were present in large numbers, and in some cases the mites were crawling about. The species was identified by Mr. Nathan Banks as *Tetranychus bicolor* Banks.

The season was also remarkable on account of the unusual prevalence of the apple leaf miner, *Tischeria malifoliella* Clem., in certain parts of the state, where it did considerable damage.

The species occurs every year, but has not hitherto been regarded as serious. It was so abundant and injurious in the vicinity of the agricultural college at Storrs that a bulletin was issued regarding it.

The eggs of the white-marked tussock moth (*Hemerocampa leucostigma* S. & A.) have been sent in by many correspondents, who mistook them for gypsy moth eggs. They were very common in Stonington and other portions of the state. A few eggs of the rusty tussock moth (*H. antiqua* Linn.) were received, but judging from the eggs received and observed, this species is much less common here than in northern New England, where it is one of the commonest species.

In June Mr. Walden found in a peach orchard a sawfly, being a new species of the family Lydidae, laying eggs on the leaves, which were afterward devoured by the larvae.

GYPSY MOTH WORK IN CONNECTICUT.

The occurrence of this insect within the State was not known to me until March, 1906. The report for 1905 being still unprinted, an illustrated account of the gypsy moth and of its discovery in Stonington was given on pages 246 to 254 of that report, as well as in Bulletin No. 153.

The work of fighting the insect was begun the day that its presence in Connecticut was established. As the eggs commence to hatch about May 1st, it was imperative that immediate action be taken to prevent the spread of this pest and to wipe it out if possible. We secured from the Massachusetts authorities, through the kindness of the Superintendent of Gypsy Moth work, Mr. A. H. Kirkland, the services of a trained inspector or scout, Mr. C. S. Mixter, who on March 20th began his examination of the infested region. Mr. Mixter inspected the trees in the village, as far as Wequetequock on the highway to Rhode Island, about as far north as the Hull estate, and as far west as Quambog Cove, covering an area of about five square miles. Egg-masses were found around the velvet mill and north and west of it, and one egg-mass was found in the apple orchard across the street in front of the school house. About thirty egg-masses were found and destroyed before the

time for hatching, and it was supposed that nearly all had been gathered. Several were found on the low bushes around Elihu's Pond near the velvet mill, which were cut over an area of about five acres, and burned April 26th, before the eggs hatched.

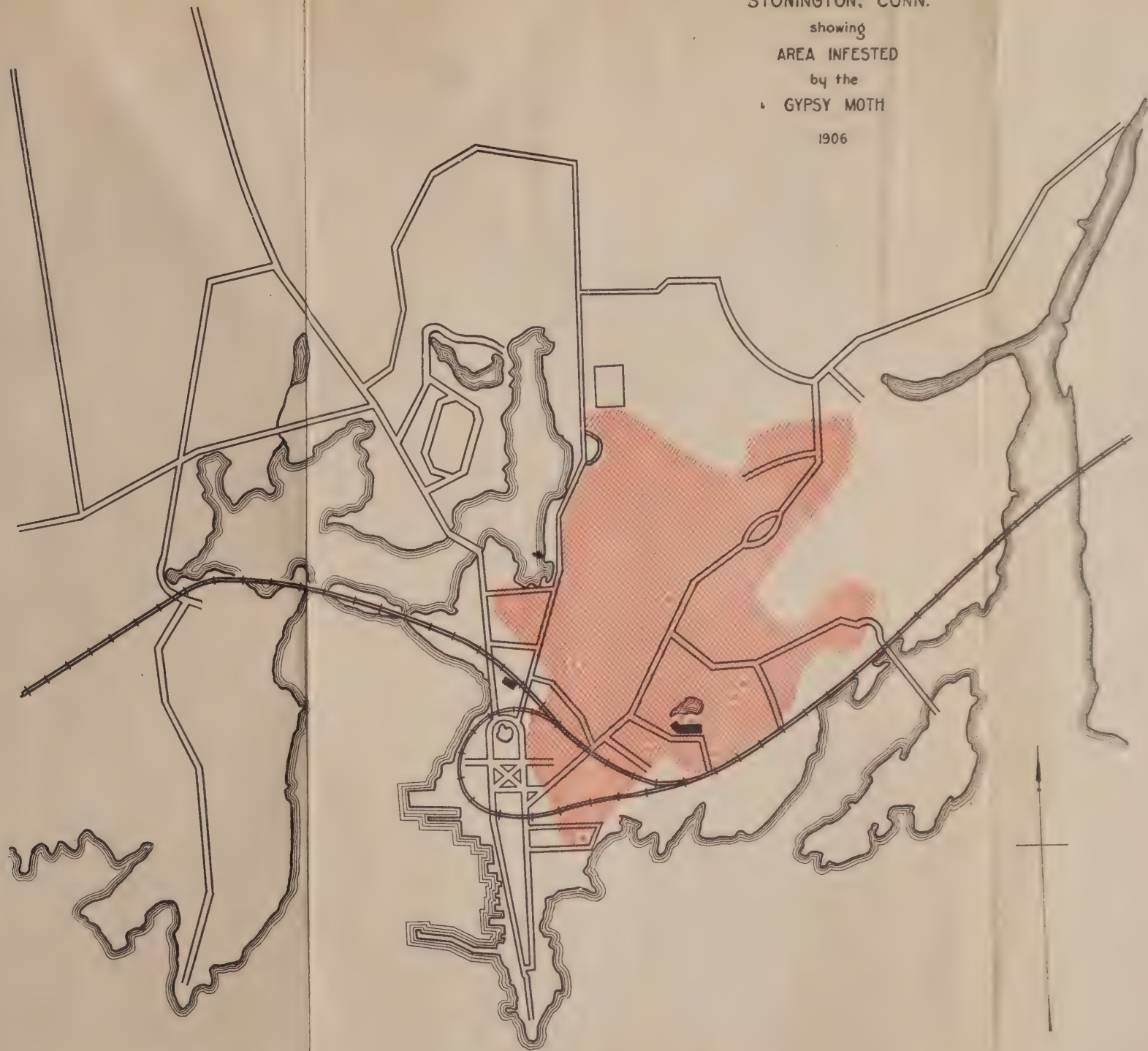
Though Mr. Mixter's examination fixed the approximate limits of the infested area, the time that he could be spared from his work in Massachusetts was too short to make a thorough search in obscure places. Hence a number of egg-masses were overlooked, hatched, and were found one by one during the work of banding trees and destroying caterpillars in June and July. In all thirty-six egg-masses were discovered which had hatched out after it was thought that all had been destroyed. This state of affairs made the work much more complicated than if these egg-masses had been found and destroyed previous to the time of hatching.

The method was adopted here which has proved so effective in Massachusetts,—trapping the caterpillars under burlap bands. Though the first bands were placed on trees about the middle of May, few caterpillars were found under them until about the first of June. Up to this time the work had been managed from the office in New Haven, and no one connected with it had resided in Stonington. Several trips to Stonington were made for the purpose of examining the bands, but it soon became evident that it was necessary to have some one employed constantly on the work in order to ascertain the exact conditions existing in the infested region. Consequently Dr. Britton went to Stonington, June 7th and remained until June 17th. Mr. Walden then took charge of the work until July 1st, after which it was in the immediate charge of Mr. James A. Hyslop, a student from the Massachusetts Agricultural College. In the caterpillar season extra help was needed; two Stonington men were employed, and several were sent out from New Haven, including two members of the station force of helpers. Later a number of local men were hired by the day to cut and burn brush. The wages paid for labor of this kind was \$1.50 per day of eight and one half-hours, and some of the young men were paid \$1.00 per day and board for banding trees and collecting caterpillars.

MAP OF
STONINGTON, CONN.

showing
AREA INFESTED
by the
• GYPSY MOTH

1906



Infested area

• Egg-masses found previous to May 1906

On September 1st the work was temporarily suspended in order to make the regular inspection of the nurseries of the state, as is required by law.

On November 16th the work of cutting and burning brush, pruning and scraping trees and scouting for egg-masses was resumed under the immediate supervision of Mr. George H. Hollister, a graduate of the Connecticut Agricultural College. This work is now going on, and the region is gradually reaching a condition far more favorable to the exterminative work than it has been during the past season.

The map facing page 236 shows the size of the area at present known to be infested and also the places where the egg-masses were found prior to May, 1906. These were clustered about the velvet mill as a center and the railroad is but a few rods distant.

The detailed description of the remedial measures adopted are given in the following paragraphs:

STATISTICS.

Number of 1905 egg-masses destroyed	29
" " " " " hatched	36
" " 1906 " " destroyed	47
" " " caterpillars	10,000
" " " pupae	47
" " trees banded (more than)	1,300

TREATING EGG-MASSSES.

The experience in Massachusetts has demonstrated that gypsy moth eggs are hard to kill, and that creosote is one of the best materials for this purpose. A little lamp black is added to the creosote in order to give a dark color to the treated egg-masses. The creosote mixture is applied by means of a brush, and enough of it should be used to soak the egg-mass thoroughly, else some of the eggs may not be killed. Creosote mixture can be obtained from most of the seed stores and agricultural warehouses in the vicinity of Boston, and costs about seventy-five cents per single gallon, but can be obtained for less in large quantities. All egg-masses should be creosoted *in situ*, as an attempt to remove them generally results in breaking the mass and scattering the eggs, which will hatch the following spring.

BANDING TREES WITH BURLAP.

Banding was commenced on May 16th, when 37 trees in the center of the infested region were banded with strips of burlap from eight to ten inches wide, placed around the tree and tied about the middle with wool twine. The upper half of the burlap is then folded over the lower half, covering the twine, as shown in the illustration. Light-weight, eight-ounce burlap is better than the more expensive grades for this purpose, because it is not so stiff, and rolls up better. In most of our work 40-inch burlap was cut in four strips of 10-inch breadth, but in the Massachusetts work bands only 8 inches wide are used, and burlap can now be purchased in strips ready to apply.

More bands were applied from time to time, as infested trees were found, until finally over 1,300 were in use. The caterpillars at first do not hide under the bands, but seclude themselves in crevices of the bark or under leaves. As they increase in size, however, they crawl under the bands and rest during the day time and feed at night. The men worked at banding in the morning and destroyed caterpillars in the afternoon.

Nearly all the caterpillars had transformed by the latter part of July, and only a few stragglers were afterward captured. Some pupae or cocoons were found under the bands, and the burlap was left on the trees until after the eggs had been laid, but most of the bands were removed before September 1st.

DESTROYING THE CATERPILLARS.

When we first began to look for caterpillars under the bands, we expected to find only a few, therefore a record was kept each day of the number found and the locality where taken. This system was continued throughout the caterpillar season, and in all over 10,000 caterpillars were destroyed.

At first the caterpillars were very small, and as we wished to save some of them for study, we killed them by dropping them into small vials of alcohol. This method was quite satisfactory, and was continued, though after a time the caterpillars were not saved. The territory to be covered was divided into sections; each man was made responsible for a section, and visited the bands once each day, usually in the afternoon, collecting the caterpillars with flat pointed forceps. The system

was a good one, but could not be used if the caterpillars were very abundant; it would be necessary to kill them by scrubbing the bark with a stiff wire brush as is done in Massachusetts.

STICKY BANDS.

Sticky bands are used in Massachusetts to prevent caterpillars from ascending trees not infested, or trees upon which the egg-masses have all been destroyed. "Tree Tanglefoot" is one of the best preparations for this purpose, as it remains sticky for a long time. It was given a trial in our work, and we shall use it more extensively next season. By applying it directly to the bark around the trunk of the tree, all crawling insects are kept from going up the tree, and a burlap band placed above the sticky band will trap those caterpillars already on the tree.

PRUNING AND SCRAPING THE TREES AND FILLING UP HOLES.

The gypsy caterpillars, though found on a variety of trees, were mostly on the larger apple trees of the region, and in some cases it was necessary to perform considerable labor upon these trees before the caterpillars could be captured under the bands. If the top of the tree is too thick and dark, the caterpillars will not crawl down and under the bands, but seem to find adequate protection in the tree tops. Wherever the trunk and larger branches are covered with rough, loose bark, the caterpillars hide in the cracks and under the upturned edges of the bark, where they often escape notice. Many trees had holes in the trunk and branches, the result of broken limbs, careless pruning or neglect. These holes furnish daily hiding places for the caterpillars, are favorite transforming places for them, and not only the cocoons but later the adult females and egg-masses are found in them. As some of these holes are inaccessible from the ground and too irregular on the inside to be readily examined, they are a distinct hindrance to the work, and it was necessary to fill them with stones and cement to keep the insects out. (See Plate VII, b.) No record was kept of the number of such cavities filled, but 700 pounds of Portland cement was used, and this was mixed with about three times its bulk of sand.

Much dead wood was removed from these trees, and living branches pruned away if needed. The rough bark was then scraped off, leaving the trees in much better condition for conducting an efficient campaign against the gypsy moth. Incidentally it was also a great benefit to the trees.

MARKING INFESTED TREES.

All trees found infested have been marked by the method adopted in Massachusetts, so that if any new men are engaged in the work next year they will have no difficulty in knowing where the insect was found and treated the year before. All infested trees were marked in white paint with a figure 6, usually placed on the south side of the trunk. On two other sides, equidistant from the figure, and on the same level with it, were placed vertical marks or lines, signifying that caterpillars were found upon the trees in 1906. Where egg-masses were found, a horizontal line was placed at the top of the vertical mark and extending to the right and forming a right angle with it. As the trees were thus marked on three sides, one or two of the marks could be seen from any point of view. Marked trees are shown on Plate VI, b.

BURNING OUT STONE WALLS.

On June 30th a bunch of wild rose bushes growing beside the road on North Main street was found to be infested, and 955 caterpillars were gathered. The bushes stood close beside a retaining wall and this wall was burned out by forcing a flame into the crevices. For this purpose fuel oil costing $5\frac{3}{4}$ cents per gallon was forced through a spray nozzle and the spray ignited, forming a gas torch. The pressure of the pump was sufficient to drive the flame through between the stones, the heat destroying the caterpillars there. Other sections of stone wall on Messrs. Darrell's and Atwood's places were burned out in this manner during July, and Plate VI, a, shows the operation.

OVERHAULING AND RELAYING STONE WALLS.

Though caterpillars can be killed readily by a flame, egg-masses require the flame for a long time in order to destroy

the eggs inside. Consequently the burning out process is not certain to kill all the eggs. Around the places of J. Chesebro, Fred Allen, Fred Avery, and under the two cherry trees beside the road near Bella Vista, sections of the stone walls several rods in length were overhauled, and several egg-masses found. These were creosoted, and the walls relaid.

SPRAYING.

Spraying the trees with poison was not attempted until June 30th, when a number of trees on the grounds of Mr. H. Lee of Elm street were sprayed with arsenate of lead. It was then rather late for spraying work, as the larger caterpillars are difficult to kill. Two barrels of the mixture were used in the proportions of one pound of the poison in ten gallons of water. As caterpillars were afterwards gathered from these trees, it is certain that all were not killed by the poison, but had the spraying been done while the caterpillars were small, it surely would have proved more effective.

CUTTING BRUSH.

It has been mentioned that about five acres of brush around the pond by the velvet mill had been cut over and burned prior to May 1st, 1906. During the progress of our work it became evident that the brush and the stone walls, especially where both occur together, constituted the greatest hindrance to the extermination of the insect and that it was very necessary to cut and burn, in order to surround the infested area with a zone where there was little or nothing for the insect to eat and which would therefore serve as a barrier to further spread of the infestation.

The present statutes do not empower the state entomologist to destroy property of any kind, though he may under certain conditions order the owner to do so, and a failure to execute the order is punishable by a fine. Yet as the work here was aimed toward an extermination of the pest from this locality, it was deemed best to have it done under our direction rather than oblige the owners to do it. Therefore the owner's permission had to be secured in each case. Several men were kept

busy cutting brush during the last week of July and the month of August. Nearly all the brush was cut around the worst infested sections, but some of it was not burned until November.

The selectmen of Stonington, after consultation, had a force of men cut the brush on North Main street from the railroad station as far north as the Hull estate; through Loper's Lane; and out the Westerly road as far as Davis' ledge. This brush was all burned in August by our men.

Late in November a force of men under the supervision of Mr. G. H. Hollister finished burning the brush cut in August, and cut and burned over a large area further north.

SCOUTING IN OTHER PLACES.

Mr. Mixter examined trees along the railroad in the vicinity of New London during the first week in April. On April 16th Mr. Walden, assisted by F. B. Kellogg and O. M. Butler, scouted the regions of Mystic and Midway, going first to Mystic and examining the trees along the railroad both east and west from the depot and for a distance of about two hundred yards from the railroad track. This included the street trees and all of the many fruit trees in yards and gardens. In the afternoon the region about Midway was scouted, the area north of the tracks and east of the depot being covered with small scattering oak and birch trees. A narrow strip next the freight yard was examined. A number of scattering trees south of the freight yard and the wooded hill near the icing plant were all carefully looked over. The orchard south of the tracks and west of the river was also inspected.

The following day Plainfield, Danielson and Putnam were visited for the same purpose. There are few trees near the railroad station at Plainfield, but a little way to the north and west of the tracks a young apple orchard was examined, and also some forest trees along a stream east of the tracks. Some fruit trees in two or three yards east of the depot and the shade trees along the main street were looked over for a distance of about two hundred yards. The native vegetation along the railroad towards Providence for some distance was examined.

At Danielson the few trees near the railroad to the north and west were carefully examined.

In Putnam the trees on a strip about a block wide each side of the railroad and extending northward as far as the bridge crossing the tracks, and southward as far as the houses extend, was carefully inspected. Mr. Kellogg scouted around Willimantic during the forenoon of April 18th, but we have no record of the exact territory examined. The gypsy moth was not found at any of these places.

Later in the season visits were made to Westerly and Watch Hill, R. I., Mystic, Noank, Groton, New London and Norwich, and though no systematic search was made, a constant watch was kept for some indication of the presence of the pest, but none found.

EDUCATIONAL WORK.

As the gypsy moth has already appeared in Stonington, and as it may be found at other points at any time, and may finally spread throughout the state, the importance of having the people familiar with it cannot be overestimated. They will then recognize it when it appears, and thus be prepared to combat it.

A bulletin (No. 153) was prepared and sent out in March, treating of both the gypsy and brown-tail moths. This publication was illustrated with the best text-figures that we could obtain at short notice, and was printed in an edition of 10,000 copies. A portion of this bulletin was included in the Report for 1905 (see p. 246), with new and original illustrations. The text-figures are wood engravings, but on account of the quality of the paper on which they are printed, did not convey a good idea of the insect, and all were too dark. The cuts were arranged and printed on cards 11 x 14 inches in size, with a brief account of the gypsy moth and its ravages, for supplying schools, so that children might become familiar with the insect. A copy was sent to each public library in the state, and the following letter was sent to the clerk or secretary of the board of school visitors in each town:—

DEAR SIR:—You have doubtless learned of the appearance of the gypsy moth in Connecticut at Stonington. Probably it will later be discovered in other localities.

In order to control this terrible pest it is highly important that the people be somewhat familiar with it in advance, so that they may readily recognize it.

We have just printed, for hanging in schools and other public places, cards 11 x 14 inches in size, giving illustrations of the insect, with brief descriptions and instructions regarding habitat, damage and remedies.

A limited number will be furnished to your town without cost, if you will see that they are promptly distributed and placed in the schools. Please reply early, stating the number of cards desired.

Very truly yours,

W. E. BRITTON,

State Entomologist.

These letters were first sent to Windham and New London counties, in the eastern portion of the state, and then to adjoining counties, until the whole state was finally covered.

Of the 172 letters sent out, replies have been received from 96, and of the 168 towns in the state 95, or 57 per cent., have been supplied. A number have been given away to teachers visiting the station. An edition of 2,000 of these cards was printed.

Life history sets of the gypsy moth in Riker mounts $6\frac{1}{2} \times 8\frac{1}{2}$ inches in size were prepared, mostly from purchased material, and placed on exhibition in drug store windows in Stonington, Mystic, Groton and New London and in the post-office at Noank. Sets were also placed in the factory of the American Velvet Company and the office of the Adams Express Company at Stonington; the office of the Secretary of the State Board of Agriculture, North Stonington; the E. C. Scranton Memorial Library, Madison; the New Britain Institute, New Britain; and the Young Men's Institute, New Haven.

Samples were shown at many farmers' institutes, and other agricultural and scientific meetings during the season. An illustrated lecture on the gypsy moth was given in Borough Hall, Stonington, on Nov. 26th. Lectures and informal talks were given about the pest in different parts of the state; exhibits of specimens and photographs were made at the annual

fruit exhibit of the Pomological Society at Willimantic Fair; at Milford Grange Fair, and at the meeting of the Board of Agriculture at New Haven, Dec. 18 to 20.

Information was given out to newspaper reporters and all others, when asked for, and a signed statement explaining the progress of the work was sent to four newspapers of the southeastern portion of the state on July 7th, and this statement was copied by many other papers.

A list of references to American literature on the gypsy moth was published in the monthly book list of the State Board of Education for July. This list was in large part prepared by the state entomologist.

REARING ADULTS FOR EXHIBITION.

On account of the difficulty experienced in obtaining material illustrating the life stages of the gypsy moth, we took advantage of the opportunity to secure material of this kind within the state. A breeding cage (see Plate VII, a) about $3 \times 3 \times 5\frac{1}{2}$ feet was built, having wood bottom and frame covered with wire netting. Caterpillars were collected from the bands, placed in this cage, and fed upon apple leaves until they reached the proper size for inflating. Some were inflated to show the larval stage, others were allowed to reach the pupa stage, while the remainder were kept until the adult stage had been reached and several egg-masses obtained. This gave us an opportunity to observe the habits of the insect, and material was obtained for about thirty-five complete life-history sets.

This breeding cage was kept within the already infested area and secured by a lock.

FUNDS FOR CARRYING ON THE WORK.

At the start, the only money available for suppressing the gypsy moth was a part of the annual appropriation of \$3,000.00 made by the legislature to the station for the expenses of the state entomologist in insect work. As this work has been organized and conducted for five years under the present management, the office force and the traveling expenses, especially during nursery inspection, require a large part of the fund. Nevertheless, some of it was available for this work, and

the Board of Agriculture promptly and kindly placed at our disposal \$2,000.00 of their appropriation in case it was needed. The Governor and other members of the State Board of Control gave us to understand that if additional money was needed after these funds were expended, it would be forthcoming. We drew upon the treasurer of the Board of Agriculture to the extent of \$800.00, and the rest of the money expended in the work came from the insect pest appropriation.

It was extremely fortunate that through the appropriation for entomological work the State of Connecticut had made it possible to vigorously attack the gypsy moth as soon as it made its appearance and that the funds of the State Board of Agriculture, and the disposition of the members of the Board, made it possible to continue the work when the funds of the entomologist were exhausted.

LOCAL COÖPERATION.

I desire to here express my appreciation to those citizens and residents of Stonington who have taken an interest in the work.

It was very fortunate for Connecticut that Mr. Ernst Frensch let the matter be known so early in the history of the moth colony. Had it gone another year before the matter was brought to our attention, it would have been more difficult to control it.

The board of selectmen, consisting of E. P. Couch, James E. Lord and Charles H. Holdridge, deserve commendation for promptness in cutting the brush along the highways for some distance outside the infested region, when they learned that it would facilitate our work.

Mr. E. M. Phelps expended considerable money in cutting the brush on his own land, which is near the border line of the infested region. It is hoped that more property owners will clean up their own land in this way, and not throw the expense of the work wholly upon the state.

CONGRESSIONAL APPROPRIATION FOR GYPSY MOTH WORK.

During the last few days of June, near the close of Congress, the agricultural appropriation bill was passed. This appropriated \$80,000 to be used by the Bureau of Entomology of the United States Department of Agriculture against the

gypsy and brown-tail moths. When this appropriation finally became available the caterpillars were nearly full-grown, and the state work at Stonington was well organized and a force of men at work destroying caterpillars. Nevertheless the Bureau of Entomology wasted no time, but engaged as its field agent in charge of this work Mr. D. M. Rogers, who had been assistant superintendent of the Massachusetts work under Mr. Kirkland. Mr. Rogers visited Stonington on July 14th and looked about the infested region, inspected the work and made a number of suggestions, which we adopted. Mr. Rogers again visited Stonington on August 18th.

GOVERNMENT COÖPERATION.

I was asked by telegram to meet Dr. L. O. Howard, Chief of the Bureau of Entomology, at Boston, July 18th. Prof. E. D. Sanderson of New Hampshire and Mr. A. E. Stene of Rhode Island were also present, and we talked over coöperative work. Dr. Howard inquired what he could do for us in Connecticut, and stated that the Bureau would take some of our men upon its pay rolls, or they would take a certain part of the territory and put in men to do all the work.

I replied that I believed the area infested to be a small one; that at present we had adequate funds available; that our work was organized and well under way; that the caterpillars were comparatively few in number, and therefore the danger of their spreading was not great; that cutting brush and cleaning up so that we could better fight the pest next year was the chief work to be done. I told him that I believed that Connecticut could handle the problem at Stonington, but that if later we needed help or funds, or should the pest be found in other parts of Connecticut, we might be very glad to have the Bureau coöperate in the work. Dr. Howard expressed his opinion that it would be best for each of the infested states to first expend some money in the suppression work.

It was therefore arranged that the Bureau should begin work in New Hampshire, Massachusetts and Rhode Island, and for the present not put men into Connecticut.

In November it was arranged by correspondence that the Bureau send some scouts to hunt not only around Stonington

but also in other portions of the state, and it is expected that this work will soon be started.

HOW DID THE GYPSY MOTH REACH CONNECTICUT?

There has been much speculation regarding the introduction of the gypsy moth into Stonington. Perhaps it will not be known just how it came, but as Stonington is only fifty miles from Providence, which has been infested for several years, and less than one hundred miles from Boston, it seems probable that the pest was brought from one of these places. The species was first discovered by Mr. Frensch near the railroad

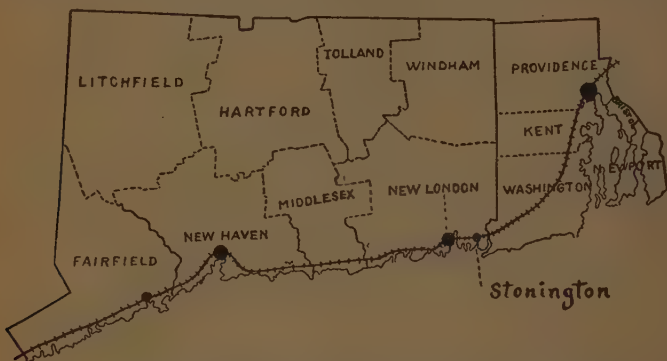


FIG. 2. Map of Connecticut and Rhode Island showing location of Stonington.

at the point where the spur track leading to the dock, branches off from the main track. There are side tracks here where cars are left standing. Few trees grow in this immediate vicinity, and those are toward the velvet mill. The gypsy moth may have been brought in the egg or pupa state on packing boxes to the velvet mill, and of course may have been dropped from passing automobiles.

On the other hand, it has been suggested that it may have been a direct importation from the old country. A number of Germans work in the mill and live close by, and as these people occasionally travel back and forth, eggs may have been brought with their baggage, accidentally, of course. This is possible, but the first theory here given seems the most probable explanation of its occurrence in Connecticut. Fig. 2 shows the relative location of Stonington and Providence.

CONDITION OF THE INFESTED AREA IN MASSACHUSETTS.

In June, as a delegate with Secretary Brown of the Board of Agriculture, I attended by invitation an exhibition of gypsy moth work at Malden, Mass., which had been arranged by the superintendent of the work and the Massachusetts Board of Agriculture. The various spraying outfits and special devices for banding trees, destroying caterpillars, etc., were exhibited, as well as the tremendous damage caused by the pest. Dead trees and hundreds of acres defoliated made a lasting impression of the destructiveness of the gypsy moth.

The next day was spent with Superintendent Kirkland and Dr. E. P. Felt of Albany, N. Y., in going through the infested portion of the state by automobile. At the insectary at Saugus we saw the breeding cages of the imported parasites and predaceous beetles.

The whole visit was very instructive and proved to be of great help in our Connecticut work.

The worst infested area of Massachusetts includes the towns of Medford, Melrose, Malden, Saugus, Wakefield, Stoneham, Woburn and Winchester. In the country districts between the populous centers is where the most damage had been done. In some places the fields of grass were thoroughly infested and the yield of hay greatly lessened. In walking over such a field, one would find a number of caterpillars crawling on his trousers and other clothes. Along the roadsides the same condition was found, and the shrubbery was brown through defoliation. Caterpillars fairly swarmed upon the trunks of trees, and over the ground in some places. This condition showed the extreme danger of the caterpillars being carried on vehicles, for after examining the trees, we had to inspect each other and take off the caterpillars, or we might carry them with us for a long distance in the automobile.

It should not be understood, however, that this condition exists everywhere,—it is so in some of the worst infested localities, because, as Superintendent Kirkland informed us, they had not yet been able, with the funds and forces at their command, to clean up these outlying districts. In each town, the work, as soon as organized, was commenced around the city or village, and gradually extended outward. We saw the street

trees and the shade and fruit trees of private gardens in good condition, and few caterpillars were to be seen. I do not remember seeing a single caterpillar in Boston. In Cambridge the street trees were banded, and numerous black spots on the bark of trunks and branches showed where egg-masses had been creosoted. But the amount of money required to hold this pest in check where it has once gained a foothold is simply enormous.

PRESENT DISTRIBUTION OF THE GYPSY MOTH IN AMERICA.

From the original infestation in Medford the gypsy moth spread in all directions, going somewhat faster toward the northeast, until in 1900, when the work was discontinued, the pest covered an area of 359* square miles. The northeastern limit was Manchester, and it was found as far west as Lincoln and as far as Hyde Park to the south. There was also a detached area at Georgetown. In 1905 the infested area was 2,224* square miles, the western limit being Marlborough. It extended from Wareham on the south entirely across the remaining portion of Massachusetts though the coast region of New Hampshire into Maine, where it has been found at Kittery, York and Eliot.

The infestation in Rhode Island extends over the entire city of Providence and a portion of Cranston, being nearly twenty-five square miles in extent. In Connecticut about one square mile is known to be infested.

METHODS OF SPREADING.

The gypsy moth would spread very slowly if not transported. The females fly but little if any, and often die on or near their egg-masses and not far from the cocoons from which they emerged. Mr. Frensch believes that the unfertilized females can and do fly as far as two hundred yards, but the evidence gathered in America does not bear out his belief. Fernald states† that he has never known the females to fly voluntarily either in this country or in Europe, and he has observed them in both places. They will sometimes drop when disturbed, and

* Kirkland. First Annual Report of the Superintendent for Suppressing the Gypsy and Brown-Tail Moths. January, 1906.

† The Gypsy Moth, p. 344.

by spreading their wings they can flutter or sail slowly to the ground a few feet away from the tree. Mr. Mosher observed one in the forest at Woburn, Mass., in 1895, which thus flew about twenty feet.* During the season Mr. Hyslop took females from our breeding cage and placed them at different positions on the walls and about the room in his house. Both fertilized and unfertilized females were tested regarding their ability to fly, the former before and after ovipositing. In all cases the results were the same. They could not be made to fly, no matter how much they were disturbed, and would do no more than drop to the ground, and few even moved their wings.

The males are not even nocturnal, but fly about in the daytime in a peculiar zigzag course, and through their scent organs are attracted at least half a mile by the unfertilized females.†

As a rule the caterpillars do not crawl far if the food supply is abundant, but sometimes when disturbed they become scattered, even where there is plenty of food. When fullgrown and about to transform, they crawl to seek sheltered places such as holes in trees, the under side of fence rails in the corners by the posts, and many caterpillars pupate under the burlap bands. But when the caterpillars become so abundant as to devour all tree foliage, as in some parts of the infested region in Massachusetts, they will crawl long distances in search of food.

The species is chiefly distributed by other agencies. When small, the caterpillars have the habit of spinning down on silken threads like the cankerworms, and may thus drop into a wagon, automobile or upon an electric car, and be carried long distances. Railroad trains are not apt to transport caterpillars in this manner because trees do not hang over the track, but baggage and persons entering the coaches might easily carry them aboard. Then as the caterpillars become larger they crawl about more, and in a badly infested region might easily crawl upon freight cars standing in the yard or upon a siding, and on the moving of these cars, might be carried many miles. Caterpillars also hide on or in these cars or some por-

* The Gypsy Moth, p. 344.

† Idem., p. 345.

tion of the freight, and there transform to the pupa stage. Ten days later, perhaps in another state or part of the country, the adult emerges.

Now if it happens that but a single specimen is carried in this manner, little harm will be done, for it will die without reproducing. But should two or more specimens representing both sexes be carried into the same locality and complete their transformation safely, a new colony arises.

Not only are vehicles and railroad trains capable of carrying caterpillars, but persons traveling about in an infested region are liable to carry the caterpillars upon their clothing, and domestic animals may carry them in their hair. It is said that even birds sometimes gather caterpillars and during flight drop them before killing them. Birds may also carry small caterpillars on their feet and feathers.

PRESENT CONDITION OF THE INFESTED AREA IN CONNECTICUT.

Though over 10,000 caterpillars were killed, it is very doubtful if any plant or tree was eaten sufficiently so as to be noticed by anyone not making a study of entomology or pests of plants. Had these caterpillars lived, they might as they became larger have done enough injury to attract attention.

Some leaves were more or less eaten, but this might have been attributed to canker worms or tussock moths, the latter being abundant.

At the present time it is difficult to find any egg-masses, or in fact any traces of the presence of the gypsy moth in Stonington, except for the marked trees and the cutting of the brush along the roadsides and around the fields. Altogether, the region is being put into a condition favorable for a successful campaign against the insect next season.

NATURAL ENEMIES OF THE GYPSY MOTH IN CONNECTICUT.

In gathering caterpillars from the bands a number of other insects, especially beetles, were found under the bands. Most of these doubtless crawl under the bands, like the gypsy caterpillars, to hide from their enemies, and there remain during the day. A large green carabid beetle, *Calosoma scrutator* Fabr., sometimes called the "searcher," was rather common under

the bands. As the beetles of this family are known to be predaceous, it was thought that this species, which is a large one, might devour gypsy caterpillars. Mr. Cleveland captured one and took it home alive and fed it some of the gypsy caterpillars, which it ate greedily. He kept a record for thirteen days with the following results:

July 10	6
11	11
12	7
13	12
14	10
15	7
16	14
17	10
18	9
19	16
20	10
21	14
22	12
13 days.	137 caterpillars.

Thus in thirteen days the beetle devoured 137 gypsy caterpillars, or an average of 10.5 per day. A member of Mr. Cleveland's family then fed the beetle with some caterpillars which had been killed by dropping them into alcohol. The beetle ate these greedily and soon died. This beetle is shown on Plate II, c. The men were then cautioned not to destroy these beetles.

The writer visited Eastern Massachusetts during the last week of June, and saw many caterpillars which had died from what appeared to be a bacterial disease. These were hanging from the rough bark of the trunks of trees, and were greatly shriveled and of lighter color than the living specimens. Prof. G. E. Stone, Botanist of the Massachusetts Agricultural Experiment Station at Amherst, was called upon by Mr. Kirkland to make an investigation of this disease. Four of these dead caterpillars were found at Stonington in the course of our work. Two of these were sent to Dr. Stone, who reported that he had isolated several organisms from the caterpillars but had not then determined which one caused their death.

LIFE HISTORY AND DESCRIPTION.

The gypsy moth passes about three-quarters of the entire year in the egg stage, the eggs being laid about the first of August and hatching about the first of May. The eggs are laid in oval-shaped masses more or less irregular and about an inch long, usually on the trunks or branches of trees, but also on fences, buildings and stone walls, as well as upon any rubbish which may occur in the vicinity. The egg-masses average between 400 and 500 eggs, though the number varies greatly,



FIG. 3. Egg-mass of Gypsy moth, natural size.

and the eggs are covered with hairs from the body of the female, giving the mass a light brown color. See Figure 3 and Plate IX, a.

When first hatched, the caterpillars are very small, and are found upon the leaves. As they increase in size they feed at night and hide during the day under the leaves, in the crevices of the bark, and under rubbish or anything that will serve to protect them from birds and other enemies.

The full-grown larvae or caterpillars vary greatly in size according to their food supply, but the largest ones taken at Stonington were three and one-fourth inches long and three-eighths of an inch thick. In general the caterpillar is dark brown in color, some individuals being distinctly reddish, and others more nearly grey. There extends along the back a whitish line or stripe which appears faintly in some specimens

and is well marked in others. This line extends between two rows of colored tubercles or spots, the first five pairs being blue and the remaining six pairs bright red. These tubercles bear short, stiff black hairs. Longer light brown hairs are borne in tufts by two rows of tubercles on each side of the body, making in all six rows of tubercles bearing hairs. The front of the head or face is marked with two broad stripes nearly meeting at the vertex and diverging downward, somewhat resembling an

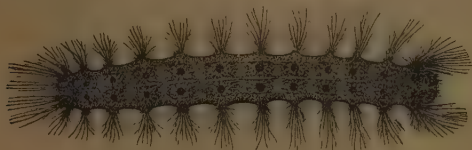


FIG. 4. Gypsy caterpillar, natural size.

inverted letter V. Between these lines the color is light brown or buff, and outside of them the same color is stippled with dark brown dots. Legs and prolegs are light brown. (See Fig. 4 and Plate VIII.) The largest caterpillars develop into females, and the sexes can usually be distinguished in the pupa stage, which is formed in July. The pupa is generally found upon trees in holes or crotches, or under fence rails, sometimes



FIG. 5. Chrysalis or pupa of Gypsy moth, natural size.

suspended by the apex, though sometimes inverted. Frequently six or eight pupae are clustered together. A loose web or cocoon consisting of a few threads of silk usually surrounds the pupa.

The female pupa is about an inch long and the male about three-fourths as large; both are dark brown in color with a

tuft of short radiating buff hair projecting from each abdominal segment. The pupa stage lasts from ten to fourteen days, and is shown in Fig. 5 and on Plate IX, b.

The adult moths emerge late in July, and the sexes are so unlike that they might easily be taken for distinct species by anyone not familiar with them. The female is nearly white, with transverse brown markings on the wings, but in some cases these markings are almost wanting. The wing expanse



FIG. 6. Female Gypsy moth, natural size.

varies from two to three inches, and the abdomen is large and heavy. The wings are weak, and the female, not being able to fly, is usually found resting on trunks of trees, fences or buildings not far from her old cocoon. See Fig. 6, and Plates IX and X.



FIG. 7. Male Gypsy moth, natural size.

The male is brown, but varies greatly in color, and the wing expanse is about one and one-half inches. The male is shown in Fig. 7 and on Plate X, and is able to fly for at least half a mile.

After mating, the females lay eggs, and both sexes soon die.

FOOD PLANTS.

Forbush and Fernald published ten years ago a list of about five hundred plants* upon which the gypsy caterpillars feed in Massachusetts. This list includes nearly all of the plants commonly grown by man, and a large number of our native species of great economic importance, as well as many others not especially important. In the very extensive feeding tests carried out in the course of the work in Massachusetts only nineteen species of plants were found which the caterpillars refused to eat. None of these plants are of such importance from the economic standpoint. In Massachusetts the insect feeds upon the foliage of nearly all kinds of trees and shrubs, the ash and the hickories perhaps being most nearly exempt of any of the shade trees. While in Massachusetts last summer Mr. Kirkland called my attention to a white ash tree with foliage uninjured, though all of the other kinds of trees near it were stripped. I also saw hundreds of acres of oak and chestnut which had been defoliated. In fact, these trees seem to be favorites of the caterpillars in the woodlands.

In Stonington nearly all of the caterpillars and many of the egg-masses were taken from apple trees. A few were found on pear, sweet cherry, quince and red apple. A clump of wild rose bushes contained nearly a thousand caterpillars. Apparently apple trees are preferred, and where the insects occur only in limited numbers they can of course exercise their preference in regard to food.

REMEDIES.

The methods of suppression set forth in the preceding pages have mostly been worked out during an extended experience in combating the insect in Massachusetts, and we, of course, have been ready to adopt the best ones, giving the Massachusetts authorities full credit.

The period in the life of the gypsy moth during which we can best destroy the pest is the egg stage,—(1) because the insect passes nine months of the year in this condition, giving us plenty of time to hunt it; (2) it does not move about in

* The Gypsy Moth, a report of about 500 pages, published by the Mass. Board of Agriculture, p. 316. 1896.

this stage, and an area which we have examined will not become infested until after the eggs hatch, except through transportation. The eggs are killed by saturating the mass with creosote, but if brush areas are infested cutting and burning is the best treatment.

During the caterpillar stage is the next most important time for us to practice remedial measures, and of these, trapping the caterpillars is probably the most important and effective if rightly managed. Bands of burlap eight to ten inches wide are placed around the trunk at a convenient height and tied at the middle with wool twine. The upper half is then folded over the lower. Caterpillars crawl under this to hide during the day, and the bands are examined every day or every other day and the caterpillars destroyed by crushing or dropping them into some liquid to kill them.

Caterpillars nearly grown are not readily killed by poison. When small, however, a spray of arsenate of lead, one pound in ten gallons of water, applied so as to thoroughly cover the leaves, will destroy many of the caterpillars. It is hardly worth while spraying unless it can be done before June 20th. Caterpillars in stone walls can be destroyed by a thorough use of the gas torch.

The caterpillar stage lasts less than two months, and the last half of this period is the best time to trap them under the bands.

The pupa stage lasts only from ten to fourteen days, hence is a short period in which to combat the insect. Pupae should be destroyed wherever they occur. Many will be found under burlap bands, under loose bark, fence rails, in holes in trees, or in fact in any secluded place.

Adult females should also be killed when found, though if they have laid their eggs it makes little difference, as they will soon die naturally, and if killed the egg-mass remains to supply the crop for next year.

IMPORTATION OF PARASITES AND NATURAL ENEMIES.

The Massachusetts law enacted early in 1905 provides that ten thousand dollars each year for three years may be expended in experimenting with parasites and natural enemies of the gypsy and brown-tail moths. Soon after being appointed,

Superintendent Kirkland sought coöperation with the Bureau of Entomology at Washington, which had been granted \$2,500 by Congress for similar purposes. Dr. L. O. Howard personally undertook the importation of parasites and predaceous beetles, and visited some of the leading entomologists of Europe in 1905, and enlisted their coöperation. Dr. Howard made a second trip to Europe in the spring of 1906. Many nests of the brown-tail moth were collected and sent to Mr. Kirkland, and were afterwards placed in cages that would allow the small parasitic insects to emerge without escaping. They were collected in tubes, in which they could be examined, and many secondary parasites and hyperparasites were found. It was necessary to destroy these, for if allowed to escape, they would parasitize the insects attacking the gypsy and brown-tail moths, and perhaps render valueless the whole attempt to control these pests by importing parasites.

Some of the hymenopterous parasites were let loose in Massachusetts during the gypsy caterpillar season of 1906.

A two-winged fly, *Tachina larvarum*, promises to be of some immediate value, according to Dr. Howard.*

Two predaceous beetles belonging to the genus *Calosoma* have also been imported, and feed upon the caterpillars.

This experiment of importing parasites is of great interest, and we hope to be benefited by it, but so many problems connected with it yet remain to be solved that no one can say what the outcome will be. People as a rule, through their eagerness for relief, place too much reliance upon the control of insect pests through the importation of parasites. The idea has been exploited in the magazines and newspapers by certain sensational writers, who make it appear not only a very simple matter, but the only rational means of controlling insect pests. This often does much harm because it discourages people from attempting any other control methods, such as spraying by banding trees. Entomologists know that the matter is not so simple as is often claimed; they know that many parasites have been imported into this country that have failed to show any beneficial results whatever. Climate, natural enemies and food

* First Annual Report of the Superintendent for Suppressing the Gypsy and Brown-Tail Moths, p. 126.

supply are factors in the prevalence of any species whether imported or not and these conditions are not under control. The lady beetle imported from China to destroy the San José scale does not thrive in the East—at least in the Northeast—and many colonies let loose have not been seen since. If parasites are imported, they are liable to be attacked by some native species of hymenoptera that will prevent them from multiplying sufficiently to do an important work in keeping down pests. When we realize that each species has its parasites, and that from the pest we may rear four or five species, each of which is parasitic upon one of the others, and only one of them attacks the pest, it will appear to be a very complex problem instead of a simple one.

But as the bringing in of parasites is not liable to prove detrimental and may prove distinctly beneficial, it is always an experiment worth trying if carefully conducted. It is to be hoped that the gypsy and brown-tail moth pests may be controlled by these imported enemies; but it would be the height of folly to discontinue other control measures, at least until after the parasites had thoroughly demonstrated their usefulness.

THE SPINY ELM CATERPILLAR.

During the first half of the summer the spiny elm caterpillar was very abundant, and defoliated trees or portions of trees in all parts of the state. Specimens were sent in by twenty-six correspondents, some mistaking it for the gypsy caterpillar, to which it has little resemblance.

The spiny elm caterpillar is the larva of one of our common and widely distributed butterflies known as the "mourning cloak," and as the Antiopa butterfly (*Euvanessa antiopa* Linn.). It feeds upon elm, poplar and willow, often stripping small trees and certain branches of large ones. The species hibernates, or passes the winter in the adult or butterfly stage.

LIFE HISTORY.

The eggs are laid in cylindrical clusters surrounding the twigs during the first half of May, when the leaves are about full size. About 300 eggs are usually found in each cluster,

though 450 have been known to occur in a single cluster. Two weeks are required for the eggs to hatch, and the caterpillars, being gregarious, place themselves side by side, with heads toward the edges of the leaf. They eat away the green portion, leaving only the network, and each spins a silken thread wherever it goes, so that something of a web is found in connection with the caterpillars, though not covering them. They eat voraciously as they become large, and devour all but the midveins. As they are still gregarious, they may be seen in large clusters on the ends of branches which they have defoliated, and therefore attract much attention. They reach full size the latter part of June or about July 1st, after having molted, or cast their skins, four times. The caterpillars then cease feeding, and scatter about seeking places to pupate, such as the underside of a rail or branch, or a hole in a stump; spinning a web of silk on the surface, it fastens itself by the tail and again casts its skin and becomes the pupa or chrysalis. About two weeks later the adults appear, and about the middle of July eggs for the second brood are deposited. The caterpillars of the second brood become fully grown about September 1st, but are not as abundant as those of the first brood in June. They then pupate, and the adults, emerging two weeks later, live through the winter in sheltered places in the woodlands, and lay eggs the following spring. We may see this butterfly on warm, sunny days in February and March flying about in the forests and pasture woodlands. There are two broods each year in Connecticut, but Weed found* only one in New Hampshire in 1899, and Felt suggests† the possibility of a third generation in New York State during certain seasons.

The adults visit various flowers to obtain nectar, and feed upon the sap of the maple and various other trees as it exudes from wounds, or from logs and branches where trees have been cut. They are not able to pierce plant tissues nor eat solid food, consequently they do no harm to vegetation in the adult stage.

This butterfly is found throughout the temperate regions of the globe, being more widely distributed than most butterflies.

* Bulletin 67, New Hampshire Agr. Exp. Station, p. 132. 1899.

† Insects Affecting Park and Woodland Trees, p. 160.

DESCRIPTION.

The full-sized caterpillar is not far from two inches in length, black in color, though sprinkled over with small white dots arranged in transverse rows, giving the caterpillar a hoary or greyish appearance. Along the back is a row of red spots somewhat diamond-shaped. Each segment bears a number of black branched spines, arranged approximately in transverse rows.

The adult or butterfly has a wing spread of about two and one-half inches, and is of a purplish brown color, with yellow margins on the wings. Many small, irregular brown spots occur in the yellow margin, and just inside it is a row of blue spots. On the under side the wings are black, with light-colored margins as above.

The pupa or chrysalis is about an inch long, suspended by the tail, with a row of spine-like projections along the ventral surface, and two pointed tubercles on the apex of the head. The color is purplish grey. All stages of this insect except the egg are shown on Plate XI.

NATURAL ENEMIES.

Spiny elm caterpillars are eaten by cuckoos, but few birds attack them, probably on account of their spines. Toads will eat them if they are found upon the ground, and a large beetle called the "searcher" or "caterpillar hunter" (*Calosoma scrutator* Fabr.) is known to feed upon them. This is the same beetle shown on Plate II, c, and mentioned on page 253 as devouring gypsy caterpillars. The most important natural enemies are insect parasites. One of these, a minute four-winged fly bearing the scientific name of *Telenomus graptae*, attacks the eggs. A number of chalcid and ichneumon four-winged flies (Hymenoptera) and certain two-winged flies (Diptera) are known to parasitize the caterpillars. As a rule, the spiny elm caterpillar is held in check by these natural enemies, and only occasionally does it appear in such numbers as in 1906.

REMEDIES.

A spray of Paris green or arsenate of lead will preserve the foliage from destruction, but as the spiny elm caterpillar is

found only here and there on a small tree or on a single branch, it is hardly worth while to practice spraying. When small, the end of the branch can be cut off, and the insects destroyed by crushing or by dipping in kerosene. When large they can be knocked off by striking the limb with a padded mallet, or with a stream of water from a hose. The caterpillars can then be destroyed upon the ground.

INSECT ENEMIES OF THE TOBACCO CROP IN CONNECTICUT.

Four years ago, or during 1903, it was planned to make a study of the insects attacking growing tobacco plants, and the work actually begun, but the season was remarkable for the scarcity of tobacco insects, and therefore little progress was made. The following season was similar in this respect, and few insects were observed on the plants in the field. In 1905 and in 1906 tobacco worms were fairly abundant in certain parts of the tobacco region, and in visiting many different fields and making collections from them we were able to acquire data regarding the various insects and the relative damage done by them. Some of these were studied in breeding cages at the station; plants growing outside were covered with cages, and the insects placed upon them and the injuries noted.

From the various papers which have been published regarding the tobacco insects of other sections of the country, it appears that Connecticut tobacco fields are more nearly exempt from the attacks of insects than are the fields of most other tobacco-growing regions of North America.

KEY TO THE COMMON INJURIES TO TOBACCO PLANTS CAUSED BY INSECTS.

Roots and stem injured—

- Plants, when small, cut off near the ground, or leaves eaten during the night.
 Fat brown or grey worms coiled up just beneath the surface of the ground near the injured plantsCutworms.
 Slender yellow worms boring in the roots and lower stem below the surface of the groundWire worms.

Leaves eaten—

Leaves, in July and August, wholly devoured except midrib by green caterpillars with horn on tail; caterpillars finally becoming three to four inches in lengthTobacco worms.

Surfaces of leaves (chiefly under surface) eaten so as to form whitish spots or patches which later drop away; injury caused by small black jumping beetlesFlea beetles.

Irregular holes in leaves, or edges eatenGrasshoppers or tree crickets.

Leaves punctured by sucking insects—

Large top leaves wilting from puncture of midvein Spined Tobacco Bug.

Green insects with long legs and antennae on under surface of lower leavesPlant Lice.

Whitish scale-like larvae on under surface of leaves. White moth-like adults flying aboutWhite Fly.

Eating dried tobacco—

Small circular holes eaten by brown beetles, larvae often found in the burrows. Stored tobacco, cigars and cigarettes attackedCigarette Beetle.

CUTWORMS.

Cutworms are the larvae or caterpillars of several species of moths of the family *Noctuidae*, commonly called owlet moths. They cause much injury to gardens and field crops of all kinds, but are especially injurious where the plants are transplanted from frames or seed beds into the fields which have recently been plowed and harrowed. As a rule the operations of fertilizing the soil, plowing and harrowing take time, and several days perhaps elapse from the plowing of the field to the setting of the plants. During this time the cutworms are in the soil, and are forced to go without food, as the weeds and other plants have been destroyed by plowing; consequently they are very hungry, and attack the plants soon after they are set. Tobacco, cabbage and tomatoes are the crops most seriously injured, these being the crops grown most extensively from transplanted plants. Crops grown from seed are also often seriously damaged by cutworms.

Most species of cutworms have but one brood each year and the eggs are laid upon grasses during the latter part of the summer. The larvae feed upon the roots of grass and other plants, going deeper into the ground on the approach of cold weather. In the spring they come to the surface of the soil and attack the plants, usually cutting them off.

Fall seeding with rye undoubtedly serves to furnish food for cutworms. Cutworms are usually more destructive on sod land or in fields surrounded by grass than elsewhere.

In June, 1905, cutworm injury was extremely severe throughout Connecticut, and in the tobacco fields it was necessary to reset plants one or more times in many cases. The writer visited the experiment field at Poquonock, and found that even the tobacco growing under cloth had been attacked, though probably not more seriously than that growing outside. Over one hundred cutworms were collected from the soil under or around injured plants of the shade-grown tobacco, and brought to the laboratory. Nearly all appeared to be larvae of *Agrotis ypsilon* Rott., known as the black cutworm, although the adults were not reared. This species is reported by Quaintance* as being the most common cutworm attacking tobacco in Florida, and Garman states† that it is especially destructive to newly set tobacco plants in Kentucky.

The injury to plants at Poquonock was marked by a lack of uniformity. Some plants were cut off just above the ground, some were severed three or four inches from the soil, and in many cases the cutworms had climbed higher, and instead of attacking the stems, had eaten away portions of the leaves, as if tobacco worms had been at work. No tobacco worms could be found, and as the cutworms were always discovered in the soil near the plant, there is little doubt about the cause of the injury.

Though the black cutworm seemed to be the most common, there are several other species doing similar injury in Connecticut. These belong chiefly to the genera *Agrotis*, *Feltia*, *Noctua* and *Peridroma*. As the treatment for cutworms is general and applies to all species, we need not discuss them

* Bulletin No. 48, Florida Agr. Expt. Station, p. 181. 1898.

† Bulletin No. 58, Kentucky Agr. Expt. Station, p. 97. 1895.

separately here. In general all feed at night, and go under boards or rubbish or beneath the surface of the soil, where they remain coiled up during the day. They vary in color from a dirty white through the greys and browns to nearly black. Markings more or less inconspicuous serve to distinguish the species, but the grower seldom observes the markings, and it really makes no difference to him which species is causing the injury. The adults are all sombre-colored moths which fly at night and hide away in dark places to remain quiet during the day. The accompanying figure of the black cutworm will also serve to illustrate the other species.

When fully grown the black cutworm is about one and one-half inches in length and about one-fourth of an inch thick.



FIG. 8. The black cutworm *Agrotis ypsilon*. (After Howard, Bureau of Entomology, U. S. Department of Agriculture.)

Its color varies, but is usually a dull grey, brown or sometimes nearly black, with rather indistinct pale lines along the sides. The head is darker than the body, and the tips of the jaws are black. See Fig. 8.

The adult moth has a wing expanse of about two inches, and the head and body together extend from three-fourths of an inch to an inch. The forewings are brown, sometimes light and sometimes nearly black, marked rather inconspicuously with fine curved black lines. The apex of each is crossed by fine undulating white lines interspersed with dark and light spots, giving the entire end of the wing a paler color than the ground portion. The rear wings are nearly white, shaded with brown along the veins and margins, and edged with short white fringe. The adult is shown in the photograph reproduced on Plate XV, c b, and in Fig. 8.

Remedies against cutworms are trapping, fall plowing, and the use of poisoned bait, the latter being the most efficient and most practiced in tobacco fields. The best bait is probably a poisoned mash made of bran or wheat "middlings" with a little Paris green or white arsenic added, with enough molasses to sweeten it slightly. A teaspoonful of Paris green and a similar or larger quantity of molasses should be sufficient for each half-peck of bran. The mash should be scattered about over the field a few days before the plants are set, as the hungry cutworms will eat it and thus be prevented from injuring the plants. Some growers place a ring of this mash around each plant, and report no injury from cutworms. Mr. Roscoe H. Gardner of Cromwell stated in the writer's presence that his practice consisted of mixing one pound of Paris green with a sack of bran and placing a pinch of the mixture by the side of each plant; very seldom a plant was injured by cutworms. The chief objection to these last two methods is the labor required in distributing the mash. If placed upon the field at intervals of several feet apart a few days before the plants are set, most of the cutworms will find it and die without injuring the plants. This appears to be much the best remedy that can be recommended.

Another method is to distribute over the field bunches of poisoned clover or other fresh succulent plants upon which the cutworms feed.

Cutworms are sometimes trapped by placing small pieces of board about on the surface of the ground. The cutworms will crawl under these to remain during the day, and can be hunted and killed. In small gardens they can usually be controlled by hunting them each morning around the injured plants.

Late fall plowing uncovers many cutworms, exposing them to birds and other natural enemies, but it also turns under the hardy weeds and other plants growing upon the field, so that the food supply for the following spring is destroyed; the cutworms are then obliged to go to some other field or starve. Early fall plowing will tend to drive the cutworms to adjacent fields in search of food except where seeded with grass or rye, in which case they can find it without migrating.

WIREWORMS.

Few accounts of wireworm injury to tobacco occur in the literature of economic entomology, though Howard mentions* the fact that they are sometimes injurious to young plants soon after they are set out, and Targioni-Tozzetti lists † nine species that attack tobacco in Europe.

Wireworms are the larvae of click beetles (family *Elateridae*), and are usually long and slender, of yellow or brown color and of firm texture. They are able to work their way into hard substances, and for the most part feed upon seeds, roots, tubers or other portions of plants under ground. Many other kinds feed doubtless upon decaying vegetable matter, and are not harmful in agriculture.

On June 11th Dr. Clinton brought in specimens from the tobacco farm of Mr. E. S. Hale in Portland, where many plants had been injured by wireworms. Mr. Walden visited the fields on the next day and found the wireworms attacking the roots and lower stem of the plants, causing serious injury. About five-eighths of an acre had been plowed up because the plants had been ruined. In a row of 225 plants, 80, or over one-third, showed injury, but this degree of injury and infestation did not extend over the entire field, and an adjacent field had only an occasional plant showing injury.

In some cases four or five wireworms were at work in the main root of a single plant, just beneath the surface of the ground. Two species were found here causing the injury, *Melanotus cribulosus* Lec. and *Asaphes* sp., the latter being the more common. Adults of *Limonius griseus* Beauv. were found the same day resting on the plants. Though this is the only case of wireworm injury to tobacco that has come under our observation, the Connecticut tobacco growers report occasional injury, and from the appearance of Mr. Hale's field it is evident that wireworms may cause considerable damage.

Some of the most elaborate experiments in this country with wireworm remedies have been conducted by Messrs. Comstock and Slingerland of the Cornell Experiment Station,‡ and of

* The Principal Insects Affecting the Tobacco Plant; Yearbook of the U. S. Department of Agriculture for 1898, p. 122.

† Animali ed Insetti del Tobacco, p. 70.

‡ Bulletins 33 and 107 Cornell Univ. Agr. Expt. Station.

the many remedies which have been suggested from time to time, fall plowing is about the only one that is likely to be worth practicing. These insects live for at least three years in the larval or wireworm stage, pupating after midsummer of the third season, in earthen cells in the ground. The pupa stage lasts but three weeks, but the adults remain in these cells and do not emerge until the following spring. By plowing or other stirring of the soil in late summer or autumn many of these cells are broken and the insects destroyed.

TOBACCO OR HORN WORMS.

Year in and year out, the greatest insect injury to growing tobacco in Connecticut is caused by the large sphinx caterpillars, commonly known as horn worms, tomato or tobacco worms. These are the larvae of sphinx or hawk moths, and are called horn worms on account of the solitary horn borne upon the dorsal surface of the posterior extremity, as is shown on Plates XII and XIII. There are two species in Connecticut. The Northern tobacco worm, *Phlegethontius quinquemaculata* Haworth (formerly *Protoparce celeus* Hbn.), is the chief depredator in the tobacco fields of Windsor and East Hartford, and is the more abundant in Northern New England. The Southern tobacco worm, *P. sexta* Johansen (formerly *Protoparce carolina* Linn.), is common in the tobacco fields of Southington, and is much more abundant at New Haven than the other species. It is also the common tobacco worm of the South. Both kinds feed upon the tomato and sometimes attack the potato. There is no way of distinguishing these two species by their work, and it is often difficult to distinguish their caterpillars, though in general *P. sexta* has a red horn, whereas the horn of *quinquemaculata* is black. Both caterpillars are green with oblique white stripes on the sides of the body. In the pupa and adult stages there is no difficulty in distinguishing one species from another. The remedies are the same for both species, and it is not necessary that the grower should know them apart.

The eggs are laid separately on the under sides of the leaves, by the adults which fly only at dusk. Usually there is but one egg to a plant, but sometimes more, especially when the moths

are abundant. The eggs hatch in three days, and the young horn worm begins to feed upon the leaf, usually eating a hole through it. As it increases in size the caterpillar eats more and more, and will finally devour the entire leaf except the midrib, and may in fact eat several leaves. The horn worms are often detected by the excrement which drops to the ground or upon the lower leaves, or by the partially eaten leaves; the worms are often on the under side, where they would otherwise escape notice. These worms are seldom found in the Connecticut tobacco fields before July, and from then until the tobacco is harvested they continue to defoliate the plants.

When fully grown, the caterpillars are from three to four inches long, and they go into the ground and pupate several inches below the surface, where they remain until the following year. The pupa or chrysalis is naked, of dark brown color, about two and one-half inches long, with a curved appendage, or tongue case, on one side, which is popularly called the "jug handle." This is longer with *quinquemaculata* than with *sexta*, hence serves as a distinguishing character. See Plate XIII, b.

The adults of both species are called sphinx moths and hawk moths, and have long pointed heavy bodies with narrow wings, and a wing expanse of between four and five inches. The general color is brownish grey, and both species have black and white bands across the rear wings. The northern species has forewings marked with delicate lines, mostly parallel with the margins and all of a greyish color. The forewings of the southern species show a more brownish color and a more mottled appearance. On each side of the abdomen of both species there are five bright orange spots, and under the head the tongue or proboscis is coiled up like a watch spring. Once we took the trouble to uncoil the tongue from a specimen of *quinquemaculata*, and it measured four and three-fourths inches. This would reach to the bottom of the deepest flowers. Adults of both the Northern and Southern species are shown on Plate XIV, and tobacco worms are illustrated on Plates XII and XIII.

It is not certain whether more than one brood occurs each year, but if so, they are not well-marked, and during the latter part of the season larvae of all sizes are found. In our breed-

ing cages adults emerged as late as September 22d, whereas some hibernated as pupae. There are three and perhaps four broods annually in Florida, according to Quaintance.* Plate XIII, c, shows a tobacco worm which has been parasitized by a hymenopterous insect, and the parasites have emerged and fastened their cocoons to the back of the caterpillar. These parasites are four-winged flies, *Apanteles congregatus* Say being one of the chief species, and probably the one shown on the plate.

Remedies for tobacco worms consist in hand-picking, which is called "worming." Men are sent through the fields twice a week, every other day, or perhaps daily according to the abundance of the worms. So far as I know, Connecticut growers have never practiced spraying tobacco with poison to prevent injury from leaf-eating insects, though Garman in Kentucky† has demonstrated that so small an amount of Paris green as one pound in 160 gallons of water does not injure the tobacco, and states that spraying is coming into practice by the Kentucky growers. Quaintance writes‡ that arsenate of lead is used to some extent in Florida.

Another method of controlling this pest has been recommended for many years—that of poisoning certain flowers to kill the adults—but I doubt if Connecticut tobacco growers ever practiced it. The adult moths fly only at twilight, and by means of their long tongues they sip nectar from the flowers of the "jimson weed" (*Datura stramonium*), and doubtless from other deep-throated flowers. By placing a drop of poison in the throat of each of these blossoms, the moths would be poisoned when visiting them. But the "jimson weed" is not very common around tobacco fields in Connecticut.

As a rule tobacco worms cause no injury to tobacco under cloth, except the first year in case the pupae were present in the soil.

FLEA BEETLES.

Flea beetles are responsible for considerable injury to tobacco, especially soon after setting the plants, and even later the lower leaves are often seriously eaten. Flea beetles usually

* Bulletin 48, Florida Agr. Expt. Station, p. 155.

† Bulletin 53, Kentucky Agr. Expt. Station, p. 125.

‡ Bulletin 48, Florida Agr. Expt. Station, p. 165.

attack the under surface of the leaves, where they eat away portions of the tissue. These injured spots become dried and drop away, leaving holes in the leaves, as is shown on Plate XV, a. Sometimes the beetles feed on the upper surface of the leaves, but the results are the same. According to Howard,* in most tobacco-growing sections this injury is caused by *Epitrix parvula*, Fabr., which is called the tobacco flea beetle, and which extends from Florida west to Arkansas and northward. In the tobacco fields which we have examined during the past four years flea beetle injury has everywhere been apparent. On collecting the beetles, we were somewhat surprised to find that all were the cucumber flea beetle, *Epitrix cucumeris* Harr. We have never taken a single specimen of *E. parvula* on tobacco in Connecticut. The fact that the cucumber flea beetle attacks tobacco was mentioned by McCarthy as long ago as 1891†; it is not strange, because this species is found upon a great number of plants. Chittenden states‡ that Mr. Shamel reported, August 11, 1903, that this species was doing much damage at Tariffville, Conn., confining itself to Cuban varieties, and attacking the leaves just before picking. Though it may occasionally cause injury to the mature plants, where it is found chiefly on the lower leaves, it is most common upon small plants, which are sometimes killed, and often greatly damaged by its attack. The lower leaves are injured most, and then in turn the next ones are attacked.

I am glad to be able to state that flea beetle injury can be controlled, as our experiments of the past two years show. Several hundred plants were dipped in arsenate of lead at the time of transplanting, and no flea beetle injury resulted. Though different proportions of the poison were used, one pound in ten gallons of water proved effective, and caused no injury whatever to the plants, even where both roots and leaves were dipped. Poisoned plants were not injured by flea beetles, while untreated plants beside them were severely injured. Where the poison was used in the proportions of one pound in four gallons, the plants were severely injured. As the older

* The Principal Insects Affecting the Tobacco Plant; Yearbook for 1898, U. S. Dept. of Agriculture, p. 123.

† Bulletin 78, No. Carolina Expt. Station, p. 16.

‡ Bulletin 44, Bureau of Entomology, p. 96.

and lower leaves are the ones eaten, this process of dipping at transplanting time fits the case exactly by poisoning those leaves which are subject to attack. Of course plants may be sprayed with an arsenical poison, but it is difficult to apply poison to the under sides of the leaves after they have been set in the field.

In dipping, a pail containing the poison mixture is large enough in which to dip twenty-five, fifty or even one hundred



FIG. 9. The cucumber flea beetle *Epitrix cucumeris*. (After Chittenden, Bureau of Entomology, U. S. Department of Agriculture.)

plants, if they are not too large. They can then be set in the ordinary manner.

The cucumber flea beetle is illustrated in Fig. 9.

GRASSHOPPERS, TREE CRICKETS, ETC.

Tobacco is often eaten by various species of Orthoptera, and sometimes severely damaged. The leaves injured by grasshoppers have holes in them, or perhaps the edges eaten, the holes being larger than those resulting from flea beetle injury, but usually smaller than those eaten by horn worms.

As a rule, the plants of the outside rows and those at the ends of the rows around the margins of the field, especially if adjoining fields of grass, weeds or brush, are injured more than the plants in the center of the field. Certain of these insects make their way to the middle of the field, and there feed upon the plants. For instance, the Carolina locust, *Dissosteira carolina* Linn., the brown species so common everywhere about the fields and roadsides, flies long distances and seems to be one of the worst tobacco depredators of the grasshopper

family. The red-legged grasshopper, *Melanoplus femurrubrum* DeG., is usually common in the state, and has been observed upon tobacco.

Tree crickets are sometimes injurious, especially around the edges of the field. The commonest one is the four-spotted tree cricket *Ecanthus quadripunctatus* Beut., though the striped tree cricket *E. fasciatus* Fitch is also found feeding upon tobacco.

Other species of Orthoptera attacking tobacco in Connecticut are the Texas katydid, *Scudderia texensis* Sans-Pictet; *S. septentrionalis* Serv.; slender meadow grasshopper, *Xiphidium fasciatum* DeG.; and the short-winged meadow grasshopper, *X. brevipenne* Scudd.

As grasshoppers feed on many kinds of plants, we may expect to find any local species feeding upon tobacco plants.

THE SPINED TOBACCO BUG.

Euchistus variolarius P. Beauv.

This insect is one of the Pentatomids or "stink bugs," about one-half an inch long, and varying in color from green to dark brown. In the opinion of many growers this insect is capable



FIG. 10. The spined tobacco bug *Euchistus variolarius*. (After Howard, Bureau of Entomology, U. S. Department of Agriculture.)

of causing serious injury to tobacco by sucking out the sap, causing leaves to wilt. In 1905, several specimens were gathered, placed in a cage with a growing plant in the field, and watched. One of these bugs was seen sucking the sap

from the midrib on the under side near the base of the leaf. The leaf wilted in consequence, and did not recover until the third day, when it gradually assumed its normal condition. Afterward we could not see that the injured leaf was inferior in any way to other leaves, but some of the growers claim such leaves to be of inferior quality and somewhat lacking in size. Garman in Kentucky has observed the injuries caused by this bug, but evidently does not regard them as very serious.* This insect is shown in Figure 10.

PLANT LICE.

Green plant lice were found on the under surface of the large lower leaves of tobacco in a field at Glastonbury, July 27, 1904. The lice were not very abundant anywhere, but were scattered throughout the field. Reports from growers indicate that plant lice are frequently noticed in other sections of the tobacco region, but that almost no damage is done by these insects. In 1898 Mr. T. Pergande of the Bureau of Entomology described *Nectarophora tabaci*† from tobacco in the District of Columbia and Maryland. Howard states‡ that *N. tabaci* is found near the terminal leaves, while our Connecticut species occurs on the older leaves. Material now at hand does not enable us to decide with certainty whether or not it is identical with *N. tabaci*. There are a number of species of plant lice occurring on solanaceous plants which doubtless may attack tobacco.

Spraying the plants with common laundry soap and water (one pound in eight gallons) should kill those lice hit by the spray.

WHITE FLY.

Mention should here be made of the greenhouse white fly *Aleyrodes vaporariorum* Westwood. Though this insect has not yet been observed by the writer in tobacco fields, it always attacks tobacco plants grown for experiment upon the station

* Bulletin 66, Kentucky Agr. Expt. Station, p. 33.

† Canadian Entomologist, Vol. XXX, p. 300.

‡ The Principal Insects Affecting the Tobacco Plant; Yearbook for 1898, U. S. Dept. of Agriculture, p. 144 (also Farmers' Bulletin No. 120).

grounds. As this insect has a list of over sixty different plants, and may be carried through the winter on house plants or in the greenhouse, it is extremely probable that sooner or later it will be found in the tobacco fields. Though it may not be sufficiently abundant over large areas to damage the crop, it is reasonably certain to greatly injure many plants in portions of the field, usually nearest the buildings or points where it passes the winter. This white fly would also be able to breed in seed beds, and might be distributed over the fields on the young plants.

The eggs are very minute, and are attached by one end to the leaf. The larvae are nearly white or yellowish, oval in shape, with a fringe of wax tubes around the margin and several long wax tubes on the dorsum. They are attached to the leaf like scale insects. The adults resemble tiny white moths. All stages are found on the under surface of the leaves, and the adults fly about when disturbed. Larvae, pupae and adults are shown on Plate XVI. A more complete account of this insect may be found in the Report of this station for 1902, p. 148.

In Europe another species, *Aleyrodes tabaci* Gennadius, occurs upon tobacco,* but it has not been reported in America.

Spraying the under surface of the leaves with soap and water (one pound in eight gallons) will kill the adults and larvae. Frequent applications should be given in order to destroy those which hatch from the egg after the previous application.

OTHER ENEMIES.

The tarnished plant bug, *Lygus pratensis* Linn., is often found upon tobacco in Connecticut, and is thought to do it more or less injury. Sometimes when first appearing, the blossom buds turn brown at the tips and fail to develop further. This injury is often ascribed to the tarnished plant bug, but we have never found the insect in connection with this injury, and therefore cannot make any definite statement regarding the matter. This insect causes injury to a great many other plants by sucking out the sap, and it would not be strange if it also attacks tobacco.

* Targioni-Tozzetti, *Animali ed Insetti del Tabacco*, p. 245.

The false bud worm, or boll worm, *Heliothis armiger* Hübn., occurs in Connecticut, being found occasionally on corn, but I have never seen it injuring tobacco. Farther south, however, the caterpillar bores holes into the rolled-up leaves, or buds, and later into the seed pods. Another species, called the true bud worm, *H. rhexia* S. & A., causes a similar injury, but occurs only in the Southern States.

The "suck fly," *Dicyphus minimus* Uhler, and the tobacco leaf miner, or "split worm," *Phthorimæa (Gelechia) operculella* Zell., both attacking tobacco in the South, have not been observed in Connecticut.

The spotted cucumber beetle, *Diabrotica 12-punctata* Fabr., is commonly found upon tobacco in Connecticut, and injures it slightly by eating small holes in the leaves.

Plants in seed beds are sometimes badly eaten by slugs (*Limax campestris* Binney, and allied species), and here arsenical poison can easily be used.

The onion thrips, *Thrips tabaci* Linde, is an enemy of tobacco in Europe, but in this country it is known only as an onion pest. Recently there has appeared in Florida, Georgia and Texas another species of thrips, *Euthrips nicotianæ* Hinds, which according to Hooker* does much damage to shade-grown cigar-wrapper tobacco by sucking out the sap from the veins on the upper surface of the leaf, giving the veins and veinlets a whitish color which shows in the cured tobacco, reducing its value fifty per cent. Hooker recommends clean cultivation of the field between crops and spraying the plants twice a week, beginning while they are in the seed beds.

This tobacco thrips has not yet appeared in Connecticut.

In Texas tobacco is injured by an insect known as the tobacco stalk weevil, or "pith worm," *Trichobaris mucorea* Lec., which tunnels in the leaf stalks and in the main stem, often going down into the root. The adult is a curculionid beetle closely allied to the potato stalk weevil, *T. trinitata* Say, but does not occur in Connecticut.

Another insect which may attack tobacco is the "stalk borer" *Papaipema nitela* Guen. It tunnels in the pith of the stems of a great many different kinds of plants, including the tomato,

* Circular No. 68, Bureau of Entomology, U. S. Dept. of Agriculture, 1906.

and while I have not observed it in tobacco, I expect that it may be found therein.

THE CIGARETTE BEETLE.

Stored tobacco, cigars and cigarettes are frequently attacked by insects and injured to a greater or less extent. The chief depredator is a small beetle of the family *Ptinidae* bearing the



FIG. 11. The cigarette beetle *Lasioderma testaceum*. (After Chittenden, Bureau of Entomology, U. S. Department of Agriculture.)



FIG. 12. Work of the cigarette beetle. (After Howard, Bureau of Entomology, U. S. Department of Agriculture.)

Latin name of *Lasioderma testaceum* Duft. (formerly known as *L. serricorne* Fabr.). This beetle breeds in tobacco and many other dried vegetable products. The adults bore their way out, leaving small round holes. This, of course, ruins cigars and cigarettes, or if leaf tobacco is attacked, it is spoiled for wrapping purposes, and its value diminished. When fine-cut and other smoking and chewing tobaccos are infested, they are injured by a lessening of the amount of the substance, as well as rendering them unsightly. This beetle is shown in Fig. 11, and its work in Fig. 12. Fumigating with carbon bisulphide, or steaming the tobacco, will destroy the insect in all its stages.

Other beetles known to occasionally infest dried tobacco are the drug store beetle, *Sitodrepa panicea* Linn., the leather beetle, *Dermestes vulpinus* Fabr., and the rice weevil, *Calandra oryza* Linn. Remedies are the same as for the cigarette beetle.

SAN JOSE SCALE SPRAYING EXPERIMENTS IN 1906.

BY W. E. BRITTON AND B. H. WALDEN.

Tests of various mixtures used to kill the San José scale were made at six different places in the state during the fall of 1905 and spring of 1906. Over 600 apple, pear, peach and plum trees altogether were treated, these being situated in Norwalk, Westville, Centerville, Rocky Hill, Berlin, and upon the station grounds. Over 300 peach and plum trees at Berlin were sprayed in the fall (November 22d, 1905) with the lime, sulphur and sodium sulphide mixture. On November 23d and 24th, thirteen peach, pear, apple and plum trees at Westville were sprayed with lime, sulphur and caustic soda.

On March 13th, 106 peach trees at Norwalk were sprayed, about one-third receiving the boiled lime and sulphur wash, one-third, lime, sulphur and caustic soda, and the remaining third, the lime, sulphur and sodium sulphide mixture.

Thirty-nine trees were sprayed the first week in April at Rocky Hill, the mixtures used being the regular boiled lime and sulphur mixture, and the lime, sulphur and sal soda mixture, and "Scalecide" mixed with water in two different proportions.

TABLE I.—EXPERIMENTS AT BERLIN, NOVEMBER 22, 1905.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.	
				Winter killed.	Killed by treatment.	Alive after treatment.		
Plum	300	Badly infested.	{ 20 lbs. lime. 10 lbs. sulphur. 10 lbs. sodium sulphide. 40 galls. water. }	00	95.4	4.6	95.4	
Apple				00	98.2	1.8	98.2	
Pear		Moderately infested.		---	---	---	---	
Peach				00	98.6	1.4	98.6	
Average.....				---	---	---	97.2	

Four trees (two apple, one peach, and one Japan plum) on the station grounds were sprayed April 7th with "Scalecide" and "Surekill," two proprietary insecticides sold on the market. No twigs were cut to examine the scales previous to applying the fall treatment, because none had then been winter killed.

The exact quantities of the various ingredients used in preparing the spray mixtures, as well as the number and kind of trees treated, and the effectiveness of the mixtures, are given in the accompanying tables.

EXPERIMENTS AT BERLIN.

The tests at Berlin were in the peach, plum, pear and apple orchard of Roy B. Smith. The trees were five or six years of age, had been well cared for, and were in good condition, the majority being only slightly infested. Only a few trees including apple were badly infested, and many showed no scale at all. This small orchard was sprayed thoroughly late in November, while the scale was still breeding, and watched especially to note the effect of the treatment on the fruit buds. A few trees were left untreated as checks, and Mr. Smith states that he could see no difference in quantity or quality of bloom between the sprayed and unsprayed trees. There was no injury to the fruit buds, though this mixture is rather more caustic than the regular boiled lime and sulphur mixture. As shown in Table I, the treatment was fairly efficient in destroying the scale. When examined on January 11th, 1906, two of the apple trees showed many live scales, but considering the badly infested condition of these trees at the time of spraying, the results were as satisfactory as could be expected. A portion of one row of plum trees had many living scales,—suggesting that these trees might not have been thoroughly covered with the mixture. A large proportion of the orchard, however, including peach, pear and plum trees, showed very few live scales. The owner considered the treatment satisfactory.

WESTVILLE EXPERIMENTS.

A few fruit trees on the grounds of Mr. E. I. Gorham were sprayed with the lime, sulphur, and caustic soda mixture on November 23d and 24th. Some of the trees were badly infested,

TABLE II.—EXPERIMENTS AT WESTVILLE, NOVEMBER 23 AND 24, 1905.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
				Winter killed.	Killed by treatment.	Alive after treatment.	
Apple	1	Medium sized tree moderately infested.	{ 20 lbs. lime. 14 lbs. sulphur. 8 lbs. caustic soda. 40 galls. water.	00	97.4	2.6	97.4
Pear	5	Large and small trees badly infested.		00	93.7	6.3	93.7
Peach	4	Small trees moderately infested.		---	90	10.	90.
Plum	3 — 13	Small trees moderately infested.		---	---	---	---
		Average-----	-----	-----	93.7	6.3	93.7

and a slightly larger proportion of scale survived than in the Berlin test, and this, owing to the different conditions, cannot be attributed wholly to the difference in the mixtures applied. Table II gives the statistics of these tests. The final examination showed these trees to be in fairly good condition, and though living scales were found, they were nowhere abundant.

EXPERIMENTS AT NORWALK.

The trees were a part of the orchard of Comstock & Lyon, and were medium-sized bearing trees which had been headed rather high. Thirty-four were sprayed with a lime, sulphur, and caustic soda mixture, thirty-seven with the lime, sulphur and sodium sulphide mixture, both self-boiled; and thirty-five were treated with the regular boiled mixture. The quantities of materials used in each, and the effect of each in destroying scale, is shown in Table III.

When last examined, on October 29th, the trees were almost free from scale, had borne a good crop of fruit, and were in good condition except for the disease known as "yellows," which had appeared on a few of the trees, and some others had been removed on account of it. The figures in Table III show slightly better results where lime, sulphur and caustic soda was used, but the difference is hardly worth considering, and all of the mixtures proved efficient, and the spraying may be called successful.

ROCKY HILL EXPERIMENTS.

On April 3d and 4th, spraying tests were made in the orchards of W. F. Griswold at Rocky Hill. "Scalecide" mixed in two different proportions was tested in comparison with the lime-sulphur mixture and the lime, sulphur and sal soda mixture, on apple trees which were generally infested. These trees had been planted five or six years, and were still small enough to be reached easily from the ground by means of extension rods.

In addition to these tests, Mr. Griswold sprayed his young peach orchards of over 10,000 trees with the boiled lime-sulphur mixture.

Table IV gives the principal statistics of the experiments at Rocky Hill.

TABLE III.—EXPERIMENTS AT NORWALK, MARCH 13, 1906.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
				Winter killed.	Killed by treatment.	Alive after treatment.	
Peach	34		$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 5 \text{ lbs. caustic soda.} \\ 40 \text{ galls. water.} \end{array} \right.$	18.2	79.6	2.2	99.8
Peach	37	Medium sized bearing trees rather high headed and thoroughly infested.	$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 10 \text{ lbs. sulphur.} \\ 10 \text{ lbs. sodium sulphide.} \\ 40 \text{ galls. water.} \end{array} \right.$	21.7	76.5	1.8	98.2
Peach	35		$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 40 \text{ galls. water.} \end{array} \right.$	20.	74.5	5.5	94.5
	106						

These trees were examined January 11th. Where the boiled lime and sulphur mixtures and lime-sulphur-sal-soda mixture had been used, but few live scales were found. Traces of both these mixtures showed on the trees. The bark looked clean and healthy. Practically no difference could be seen in the condition of the trees sprayed with these two mixtures.

Many living scales were present on the trees sprayed with both mixtures of "Scalecide." The scales were especially noticeable on the new growth. The bark did not have the bright, clean appearance of that on the trees sprayed with the lime-sulphur mixtures. The figures in the table show very little difference in the results of the four sprays, and but little difference could be seen in the condition of the trees at the time the twigs were cut. The last examination, however, showed a marked difference in favor of the lime and sulphur mixtures.

NEW HAVEN EXPERIMENTS.

On April 7th, four trees on the station grounds were sprayed. All were moderately infested with San José scale and were sprayed with two kinds of so-called "soluble oils," "Scalecide" and "Surekill." Both materials were diluted, one part with 25 parts (bulk) of water. "Scalecide" was applied as a spray to two apple trees, and "Surekill" was sprayed upon a peach tree and a Japan plum tree.

When twigs were cut and examined in June, the figures obtained were decidedly in favor of the "Scalecide," as Table V shows. This verdict was later confirmed, as the peach and plum tree sprayed with "Surekill" were very badly infested late in the season.

EXPERIMENTS AT CENTERVILLE.

On the farm of Mr. George C. Neal, Centerville, 104 peach and apple trees were sprayed April 11th. Most of these were in a peach orchard from which many trees had been removed on account of injury by scale and winter killing. A large proportion of these were given the boiled lime-sulphur mixture, but two apple trees each were sprayed with "Scalecide" and "Surekill." Ten peach trees which were selected for our spraying tests were not treated because Dr. Clinton wished

TABLE IV.—EXPERIMENTS AT ROCKY HILL, APRIL 3 AND 4, 1906.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
				Winter killed.	Killed by treatment.	Alive after treatment.	
Apple	5	Generally infested.	{ 1 gal. "Scalecide." { 20 galls. water.	20.6	73.9	5.5	94.5
Apple	4	"	{ 1 gal. "Scalecide." { 14 galls. water.	19.5	73.	7.5	92.5
Apple	9	"	{ 20 lbs. lime. { 16 lbs. sulphur. { 40 galls. water. Boiled 45-60 min.	22.	72.4	5.6	94.4
Apple	11 — 39	"	{ 20 lbs. lime. { 16 " sulphur. { 10 " sal. soda. { 40 galls. water. Hot water used to slake lime. Covered and left for 1 hour.	17.8	75.1	7.1	92.9

TABLE V.—EXPERIMENTS AT NEW HAVEN, APRIL 7, 1906.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
				Winter killed.	Killed by treatment.	Alive after treatment.	
Apple	1	Slightly infested.	{ 1 gal. "Scalecide." 25 gal. water.	20	79.2	0.8	99.2
Apple	1	"		17	78.7	4.3	95.7
		Average.....					97.4
Japan Plum	1	Slightly infested.	{ 1 gal. "Surekill." 25 gal. water.	27	50.	23.	77.
Peach	1	"		19	60.	21.	79.
		Average.....					78.

TABLE VI.—EXPERIMENTS AT CENTERVILLE, APRIL 11, 1906.

Kind of trees.	Number of trees treated.	Condition of trees before treatment.	Materials applied.	Out of 100 Scales on Twigs—			Percentage efficiency of treatment.
				Winter Killed.	Killed by treatment.	Alive after treatment.	
Peach	10	Moderately infested.	Bordeaux mixture.* $\left\{ \begin{array}{l} 4 \text{ lbs. lime.} \\ 4 \text{ lbs. copper sulphate.} \\ 45 \text{ galls. water.} \end{array} \right.$	23.2	47.6	29.2	70.8
Peach	90	"	$\left\{ \begin{array}{l} 20 \text{ lbs. lime.} \\ 14 \text{ lbs. sulphur.} \\ 40 \text{ galls. water.} \end{array} \right.$ Boiled for 45-60 m.	19.1	75.4	5.5	94.5
Apple	2	Badly infested.	$\left\{ \begin{array}{l} 1 \text{ gal. "Scalecide."} \\ 20 \text{ galls. water.} \end{array} \right.$	19.8	79.9	.3	99.7
Apple	$\frac{2}{104}$	"	$\left\{ \begin{array}{l} 1 \text{ gal. "Surekill."} \\ 25 \text{ galls. water.} \end{array} \right.$	17.5	75.	7.5	92.5

* These trees received a second spraying May 23, with weak Bordeaux mixture containing materials in the proportions of 2-2-45.

DISCUSSION OF RESULTS.

The figures showing the percentage of efficiency of insecticides should not be understood as being absolutely exact, because in the ordinary experiments along this line it is not possible to obtain such definite results. In a general way, however, Table VII shows that all of the lime and sulphur mixtures were fairly effective in destroying the scale, whether applied in fall or spring. Probably there is no great difference in these so far as effectiveness is concerned if they are properly made and applied. It is often difficult or impossible to obtain locally a grade of lime that is satisfactory in making a self-boiled mixture. The boiled mixture will usually be more satisfactory than the self-boiled, if it is necessary to use mortar lime or lime which is partially air-slaked. Our experience shows no injury whatever to buds or twigs by the lime and sulphur mixture applied in the fall.

The most frequent cause of failure in spraying work is lack of thoroughness in applying the mixture. It is difficult to cover with the spray every portion of the bark on a tree from the ground to the uppermost twigs, but it is absolutely essential to do this if we would destroy the scale, or clean up infested trees. If any portion of the bark be infested and escape treatment, the work will not be wholly successful.

Table VII also shows that "Scalecide" in the proportions used gave fairly good results as a scale destroyer, while "Sure-kill" was much less satisfactory. Both were used in the proportions recommended by the manufacturers. These materials represent a comparatively new form of scale insecticide, and several other brands are now sold. The basis is petroleum, with heavy and light ingredients removed, and some of them contain certain proportions of resin oil and vegetable oil, the whole treated with caustic soda or some other alkali, to render them miscible with water. While some of these products have given good results and seem to be fairly uniform in composition, they are still in the experimental stage. There is unquestionably a demand for something of the sort to use in treating trees and shrubs in city yards, spraying growing nursery stock, or in the treatment of small orchards, especially where labor is more important than the cost of materials.

In the peach and apple orchards of medium or large size we still recommend the lime and sulphur mixture as being altogether the cheapest, most destructive to the scale, and most beneficial to the trees of anything yet tested in Connecticut.

Though "Scalecide" and other miscible oils show no injury to the trees in a single season, it is too early to say that they produce none. After being used several years we shall know better about it, and it is possible that a cumulative injury may later manifest itself. *But spray with the miscible oils by all means if you can do no better. The injury is certain to be less than that caused by the scale where not checked.*

NOTES ON FUMIGATING BUILDINGS.

By B. H. WALDEN.

Hydrocyanic Acid Gas in a Dwelling House.

On November 9th the writer fumigated a small six-room house, known to be infested with bedbugs, *Klinophilos lectularia* Linn. The house had just been vacated.*

Hydrocyanic acid gas and carbon bisulphide were considered as remedies. To get the best results with the carbon bisulphide, the generators should be placed near the top of the rooms. This is easily done in seed houses and store rooms that are nearly filled, but in the case of an empty house it appeared to be quite a problem to suspend the generators. Carbon bisulphide requires much more generating surface, hence more dishes are needed than with the hydrocyanic acid gas. It was found that the materials for the hydrocyanic acid gas were slightly cheaper than carbon bisulphide purchased in small quantities. For these reasons hydrocyanic acid gas was used.

The house was measured and found to contain a little more than 15,500 cubic feet of space, and as it was planned to use the formula recommended for fumigating nursery stock:—

Potassium cyanide 98%.....	1 oz.
Sulphuric acid 66° Baumé.....	2 ozs.
Water	4 "

36 lbs. of commercial sulphuric acid and 10 lbs. of potassium cyanide, manufactured by Harshaw, Fuller & Goodwin Co.,

warranted 98-99 per cent. were purchased, costing as follows:—

36 lbs. Sulphuric acid at 4 cts.	\$1.44
10 " Potassium cyanide at 26 cts.	2.60
	\$4.04

For generators, twelve large earthenware pudding dishes were used, having a diameter of eight inches at the bottom and twelve inches at the top, and about three inches deep. These were supplemented by three smaller granite iron dishes. The amount of cyanide for each room was weighed out and placed in thin paper bags, which were then marked for the room intended. The dishes were then prepared by having the water measured and placed in them and the proper quantity of acid slowly stirred into the water. The generators were placed in the rooms, and a bag of cyanide was placed near each generator.

The cubic contents of each room, the amount of cyanide, and number of generating dishes were as follows:

Attic	2834 cu. ft.	28 ozs. cyanide	2 large dishes
Upper hall	527 " "	5½ " "	1 " "
Front Closet	238 " "	2½ " "	* " "
Chamber No. 1.....	1324 " "	14 " "	1 " "
" " 2.....	890 " "	10 " "	1 " "
" " 3.....	689 " "	8 " "	1 " "
Bath room	323 " "	4 " "	1 small "
Lower hall and stairway	765 " "	7½ " "	1 large "
Front room	1133 " "	9 " "	1 " "
Dining room	1097 " "	10 " "	1 " "
Kitchen	1272 " "	12 " "	1 " "
Pantry	247 " "	2½ " "	1 small "
Cellar	4185 " "	35 " "	2 large-1 " "
Total	15,524 " "	148 " (9 lbs. 4 oz.)	

No battens were used around the doors and windows, as they all appeared to close tightly. The windows were locked excepting four, which were left unlocked to open from the outside in ventilating the house. The lights were then supposed to be all turned out, and the writer with a lamp giving a strong

* When the cyanide was placed it was found that no dish had been prepared for this closet which opens from the hall, so the cyanide was dropped into the dish which was placed in the hall.

light started at the attic to drop in the bags, coming down through the house leaving all inside doors open, and finishing at the cellar.

The cellar door, which locked only from the inside, had been fitted with a spring lock, so that the operator could pass out and lock the door.

It took nearly two hours to complete the operation, and it was 7:15 P. M. when the house was closed. It was discovered that a gas light had been accidentally left burning in the upper hall. This continued to burn until turned out soon after the house was opened at 4:00 P. M. the following afternoon. The house was again closed, and left until about ten o'clock the next forenoon, when it was again opened. There was a strong odor suggesting that considerable gas must have been generated during the night. The generating dishes were then removed, and windows opened in all the rooms. There were traces of the gas remaining at four o'clock P. M. The house was occupied that night, care being taken to have the sleeping rooms well ventilated.

Although it would seem hardly necessary to fumigate more than the floor containing the sleeping rooms, it was decided to fumigate the whole house in order to make the treatment very thorough. The second floor was given a slightly stronger dose than is usually given nursery stock, while in the first floor and cellar smaller quantities were used.

On the day following the fumigation three dead mice were found in the cellar; dead flies and spiders were seen in various parts of the house.

Along one side of the dining room in cracks in the floor, under the baseboard, etc., about thirty dead bugs were found. It was learned that a couch had stood at this place. A few dead bugs were found in one sleeping room. No living bugs have been found anywhere in the house, although it will probably be necessary to wait until another season of warm weather to note the effectiveness of the treatment.

The former tenants spent an average of about fifty cents a month for proprietary remedies against this pest. While these remedies may kill many of the bugs, they serve only as checks to keep them from overrunning the house. These reme-

dies are also very inflammable. The varnish of the baseboards had been injured and wall paper spotted, evidently by some treatment employed.

The hydrocyanic acid gas is perfectly non-inflammable, as is shown in this treatment, and no injury is caused to the most delicate colors or fabrics. It is, of course, a very deadly poison, and great care should be taken in its use. It is especially desirable to use where a house can be vacated for a day or two, but it also can be used in rooms which can be closed very tightly, or which are more or less isolated, while the house is occupied. The gas might be used somewhat stronger, and the rooms closed for only two or three hours.

Carbon Bisulphide in a Seed Store House.

A seed store house belonging to the Everett B. Clark Company of Milford was fumigated August 3d under our direction. The seed was infested by the European grain moth, *Tinea granella* Linn., a recently introduced pest, which had not before been reported in Connecticut.

The house was 36 feet long, 22 feet wide and 12 feet high, containing 9,504 cubic feet, and had been used for two years to store seed sweet corn. At the time of fumigating, the house was about two-thirds filled, 2,700 bushels of shelled seed sweet corn being in sacks, and over 1,000 bushels in tightly-headed barrels.

Ten pounds of carbon bisulphide were used. Three milk pans about fifteen inches in diameter and two flower pot saucers from six to eight inches in diameter were used for generating dishes. These dishes were placed on top of the sacks, so that the gas would be evenly distributed. The carbon bisulphide was divided among the dishes, and the house closed for twenty-four hours.

Another store room containing 3,840 cubic feet of space was also fumigated. In this house was stored about 975 bushels of seed sweet corn. Five pounds of carbon bisulphide were used, and the room treated in the same manner as the house which was fumigated. Both houses contained approximately 4,575 bushels of seed sweet corn which cost the owners about \$5,700. If no effort had been made to check the pest, there was danger of losing the entire stock.

The place was not visited to note results, but the owners reported that, while some live moths and larvae were found, many of the insects were killed.

Better results would probably have been obtained if more dishes had been used in which to evaporate the carbon bisulphide, and it might be necessary to use more carbon bisulphide to have the gas strong enough to penetrate the bags.

From one to two pounds of carbon bisulphide to each 1,000 cubic feet of space is recommended in a tight room, and there should be at least one square foot of generating surface to each twenty-five square feet of floor space to get the best results. The house or room should be left closed for at least twenty-four hours. Care should be taken not to have any fire around the building, as the gas is inflammable and explosive; and the fumes should not be breathed.

THE MAPLE LEAF STEM BORER.

Priophorus acericaulis MacGillivray

An insect boring in the leaf stems or petioles of the sugar maple, first brought to my attention in 1899, has been studied, with repeated attempts to rear the adults, which were finally obtained in May, 1906. It proved to be a sawfly of the genus *Priophorus* hitherto undescribed, which Dr. MacGillivray has named *P. acericaulis*.* The insect lays eggs in the stem at the base of the blade early in May, and the larva tunnels inside the petiole, leaving only the epidermis, the burrow being filled with castings and somewhat swollen. The blades break off and fall to the ground the last of May or first of June, but the petioles remain upon the tree for ten days or two weeks, and finally drop to the ground. Either before or after they fall the larva emerges through a hole in the side of the stem, and enters the ground to pupate.

The insect attacks the sugar, Norway and sycamore maples, the sugar maple being by far the most important host. Red and silver maples have been examined from time to time, but have not been found attacked by this insect. I have material from Danbury and New Haven, and have observed its work in

* Canadian Entomologist, Vol. XXXVIII, p. 306, September, 1906.

Stonington. It is also reported from Hamden, Hartford and Southington. Outside of Connecticut it is believed to occur in Canada, New Jersey and Pennsylvania.

Apparently the insect is spreading, and in the most serious cases which have come under my observation nearly one-third of the leaves have fallen about June 1st. We have not experimented with remedies, but the knowledge gained of the life history of this insect prompts us to suggest a spraying of the ground under the infested tree with kerosene emulsion about June 15th, when the larvae are going into the soil. Or if in plowed ground, cultivation of the soil at this time is certain to kill many of them. There should be little difficulty in controlling an insect which is so hard to rear.

A detailed and illustrated account of this insect and its work was prepared by the writer and published in Entomological News, Vol. XVII, page 313, November, 1906.

IDENTIFICATION OF INSECTS.

During the year 285 samples of insects have been received for identification, and in many cases the specimens were reported as causing injury to plants or animals, and advice was asked regarding treatment. I am indebted to the Bureau of Entomology for identifying several species. A classified list follows:—

INSECTS RECEIVED FOR IDENTIFICATION DURING 1906.

ORTHOPTERA.

<i>Scudderia</i> sp. ?	Katydid	Flatbush, N. Y.
<i>Gryllotalpa borealis</i> Burm.	Northern mole cricket	New Haven.
<i>Cecanthus</i> sp.	Tree cricket	Stratford.

THYSANOPTERA.

<i>Thrips tabaci</i> Linde.	Onion thrips	Fairfield.
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HEMIPTERA.

<i>Poeciloscopus lineatus</i> Fabr.	Four-lined leaf bug, 2 samples	Branford, Danbury.
<i>Psylla pyricola</i> Först.	Pear psylla, 2 samples	Guilford, Concord, Mass.
<i>Aphis pomi</i> DeG.	Apple aphid, 3 samples	Norwich, North Haven, Hillstown.
<i>Lachnus platanicola</i> Riley	Sycamore aphid	Philadelphia, Pa.
<i>Phyllaphis fagi</i> Linn. ?	Beech leaf aphid, 2 samples	Southport, Farmington.
<i>Schizoneura americana</i> Riley	Woolly elm aphid, 5 samples	Derby, Farmington, Glastonbury, Colebrook, No. Grosvenordale.
" <i>lanigera</i> Haus.	Woolly apple aphid	New London.
<i>Chermaphis abietis</i> Linn.	Spruce gall louse, 3 samples.	Bristol, So. Woodstock, New Haven.
<i>Phylloxera caryacaulis</i> Fitch	Hickory stem gall louse, 2 samples	Hartford, Stockbridge, Mass.
<i>Phenacoccus acercola</i> King	Woolly maple leaf scale, 6 samples	Bridgeport, West Haven, Danbury, New Britain, Hartford.
<i>Putevinaria innumerabilis</i> Rathv.	Cottony maple scale, 2 samples	Branford, Chatham, N. J.
<i>Eulcanium armeniacum</i> Craw.	Apricot scale	Branford.
" <i>nigrofasciatum</i> Pergande	Terrapin scale, 2 samples	Deep River, Philadelphia, Pa.
" <i>tulipiferae</i> Cook	Tulip tree scale, 2 samples	Branford, Greens Farms.
<i>Saissetia hemisphaerica</i> Targ-Tozz.	Hemispherical scale, 2 samples	Waterbury, Washington.
<i>Chionaspis euonymi</i> Comst.	Euonymus scale	Middlebury.
" <i>furfura</i> Fitch	Scurfy scale, 10 samples	Guilford, Madison, Mt. Carmel, Waterbury, Bethel, Hartford, Warehouse Point, Thompsonville, Danielson.
" <i>pinifoliae</i> Fitch	Pine leaf scale	Thompson.
<i>Aulacaspis rosae</i> Bouché	Rose scale	New Haven.
<i>Aspidiotus ancyllus</i> Putnam	Putnam's scale, 2 samples	New Haven, Storrs.
" <i>forbesi</i> Johns	Cherry scale	Pomeroy, O.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1906—Continued.

<i>Aspidiotus perniciosus</i> Comst.	San José scale, 43 samples.	New Haven, West Haven, Milford, Shelton, Guilford, Norwalk, Westport, Saugatuck, Southport, Waterbury, Naugatuck, Yalesville, Meriden, Bristol, Berlin, Newington, Hartford, Glastonbury, Portland, Higganum, Danielson, Norwich, Uncasville, New London, Ivoryton, Concord, Mass.
<i>Lepidosaphes ulmi</i> Linn.	Oyster shell scale, 10 samples	Milford, Newtown, Westville, Mt. Carmel, Durham, Naugatuck, Brookfield Center, Hartford, Putnam.
	Plant louse (on <i>Berberis iliciifolia</i>)	New Haven.
LEPIDOPTERA.		
<i>Tischeria malifoliella</i> Clem.	Apple leaf miner	Storrs.
<i>Archips cerasivorana</i> Fitch?	Cherry leaf roller	New Canaan.
<i>Bucculatrix pomifoliella</i> Clem.	Apple bucculatrix, 2 samples	Hartford, New Britain.
<i>Oxyptilus periclidactylus</i> Fitch.	Grape plume moth	Haddam.
<i>Thyridopteryx ephemeraeformis</i> Haworth	Bag worm	Philadelphia, Pa.
<i>Malacosoma americana</i> Hart.	Tent caterpillar, 3 samples	Southport, Lisbon, Mystic.
<i>Tolyte velleda</i> Stoll.	White-marked tussock moth, 10 samples	Colchester.
<i>Hemerocampa leucostigma</i> S. & A.		ington, New Britain, Warehouse Point, South Canterbury, Lisbon, Mystic.
<i>Notolophus antiqua</i> Linn.	Rusty tussock moth, 2 samples	Stafford, Litchfield.
<i>Gluphisia severa</i> Edw.		Farmington.
<i>Schizura concinna</i> S. & A.	Saddle-back caterpillar, 2 samples	New Britain, New London.
<i>Heterocampa</i> sp.	Walnut caterpillar	New Haven.
<i>Datana integerrima</i> G. & R.	Yellow-necked caterpillar, 2 samples	East Morris.
" <i>ministra</i> Dru.		Hartford, Warehouse Point.
" sp.		New Haven.
<i>Epizeuxis lubricalis</i> Geyer		Greenwich.
<i>Erebis odora</i> Linn.		Canada.
<i>Catocala cara</i> Guen.		Granby.
<i>Macronoctua onusta</i> Grote?	Eight-spotted forester	New Haven.
<i>Alypia octomaculata</i> Fabr.	Hickory tussock moth	New Haven.
<i>Haliidota caryae</i> Hart.	Virgin tiger moth	Colebrook.
<i>Diacrista virginica</i> Fabr.	Isabella tiger moth, 2 samples	New Haven.
<i>Ista isabella</i> S. & A.		Mystic, New London.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1906—Continued.

<i>Hyphantria cunea</i> Dru.	Fall webworm	Lyme.
<i>Basileia imperialis</i> Dru.	Imperial moth	Mt. Carmel Center.
<i>Aniota senatoria</i> S. & A.	Orange-striped oak worm	New Haven.
<i>Automeris</i> to Fabr.	Io moth, 3 samples	New Haven, Greenwich.
<i>Teleda polyphemus</i> Cram.	American silk worm, 3 samples	New Haven, Bloomfield.
<i>Callosamia promethea</i> Dru.	Promethea moth, 2 samples	Danlison, Kensington.
<i>Samia cecropia</i> Linn.	Cecropia moth, 2 samples	Stamford, New Haven.
<i>Smegmatus jamaicensis</i> Dru.		Farmington.
<i>Sphinx chersis</i> Hübn.		Essex.
<i>" drupiferarum</i> S. & A.		East Woodstock.
<i>Phlegonthus sexta</i> Johan.	Southern tobacco worm	Southington.
<i>Deidamia inscriptum</i> Harr.		New Haven.
<i>Sphecodina abbotti</i> Swains.	Abbot Sphinx, 2 samples	New Haven, Columbia.
<i>Hemaris thysbe</i> Fabr.	Thysbe clear-wing	Lyme.
<i>" diffinis</i> Boisd.		Hartford.
<i>Anosia plexippus</i> Linn.	Monarch: Milkweed butterfly	New Haven.
<i>Euanassa antiopa</i> Linn.	Spiny elm caterpillar, 26 samples.	
	Mourning-cloak butterfly	Sound View, West Haven, Madison, Bristol, Farmington, Collinsville, Brookfield Center, Hartford, Buckland, Windsor, Manchester Green, Glastonbury, Haddam, Saybrook, Lyme, New London, Taftville, Uncasville, Preston, Mansfield Center, Gilead, No. Grosvenordale, Woodstock.
DIPTERA.		
<i>Ceidomyia liriodendri</i> O. S.	Tulip tree leaf gall	Branford.
<i>Lastioptera vitis</i> O. S.	Grape tomato gall.	New Haven.
COLEOPTERA.		
<i>Scolytus rugulosus</i> Ratz.	Fruit bark beetle	Fairfield.
<i>Hyllobius pales</i> Hbst.		So. Manchester.
<i>Epicauta pennsylvanica</i> DeG.	Black blister beetle	Guilford.
<i>Coptoclyda clavata</i> Fabr.		Waterbury.
<i>Dibolia borealis</i> Chev.		West Hartford, Wallingford.
<i>Galerucella luteola</i> Mull.	Elm leaf beetle	North Haven.
<i>Crioceris asparagi</i> Linn.	Asparagus beetle	Plantsville.
<i>Cyllene pictus</i> Dru.	Hickory borer, 2 samples	New Haven.

INSECTS RECEIVED FOR IDENTIFICATION DURING 1906—*Concluded.*

<i>Prionus latitollis</i> Dru.	Broad-necked prionus, 3 samples	New Haven.
<i>Euphoria inda</i> Linn.	Bumble-flower beetle.	So. Manchester.
<i>Pelidnota punctata</i> Linn.	Spotted grape vine beetle	New Haven.
<i>Macrodactylus subtipinosus</i> Fabr.	Rose chafer, 4 samples	Oronoque, Wallingford, New York, N. Y., Marbledale.
<i>Lucanus dama</i> Thunb.	Stag beetle	New Haven.
<i>Lucius unipunctatus</i> Hbst.	Powder post beetle	New Haven.
<i>Podabrus basilaris</i> Say.		North Haven.
<i>Limonium griseus</i> Beauv.		North Haven.
<i>Melnotus communis</i> Gyll.	Carpet beetle	Guilford.
<i>Anthrenus scrophulariae</i> Linn.		Branford.
<i>Brachyacantha ursina</i> Fabr.	Twice-stabbed lady beetle, 3 samples	New Brita n, Uncasville, Rainbow.
<i>Chilocorus bivulnerus</i> Muls.	Two-spotted lady beetle.	Branford.
<i>Adalia bipunctata</i> Linn.	Lady beetle	West Hartford.
<i>Megilla fuscilabris</i> Muls.		Wallingford.
<i>Agonoderus pallipes</i> Fabr.	Searcher	Hartford.
<i>Cabosoma scrutator</i> Fabr.		
HYMENOPTERA.		
<i>Cimbex americana</i> Leach	Giant sawfly, 2 samples	Bristol, New London.
<i>Eriocampoides limacina</i> Reiz.	Cherry or pear slug	West Hartford.
<i>Strongylogaster pinguis</i> Norton	2 samples	New Britain.
<i>Andricus seminator</i> Harr.		New Haven.
" <i>palustris</i> O. S.		Hartford.
<i>Thalessa atrata</i> Fabr.	Black long-sting, 3 samples	Norwalk, So. Manchester, Simsbury.
" <i>lunator</i> Fabr.	Lunate long-stung, 2 samples	Simsbury, So. Manchester.
<i>Apanteles</i> sp.		Chester.
<i>Microgaster</i> ?		Norwalk.
<i>Isosoma orchidearum</i> ?		Thompson.
<i>Vespa crabro</i> Linn.	Giant hornet	Darien.
<i>Xenoglossa pruinosa</i> Say.		Bristol.
ARACHNIDA.		
<i>Tyrroglyphus longior</i> Gerv.		Winfield, Ont.
<i>Eriophyes quadripes</i> Shimer	2 samples	Hartford, Litchfield.
" <i>ulmi</i> Gar.		Greenwich.
<i>Tetranychus bicolor</i> Banks.	2 samples	Meriden, Marbledale.

NOTES.

Dipping Plants in Arsenate of Lead. In the last report of this station (1905), page 260, is recorded an experience in dipping plants in arsenate of lead when transplanting. These tests were made primarily to determine the effectiveness of the treatment against cutworms. More extensive tests have been made during the past season. The most concentrated mixture used in 1905 was one pound in ten gallons of water, and no injury resulted even when the roots were dipped. On May 21st and 22d, 1906, tobacco plants at Poquonock and tomato plants at Southington were injured and in some cases killed by dipping in a mixture of one pound of arsenate of lead in 2, 4 and 8 gallons of water, but the transplanting was done at a time of drought and high temperature.

On May 18th, 650 cabbage plants were set on land owned by S. E. Frisbie, Milford, and dipped to see if the treatment would keep out the cabbage maggot. Cabbage leaves and stems are not easy to moisten, as the water gathers in drops and rolls off. By making trials, it was found that soap would overcome this difficulty. A spoonful of soft soap or a piece of hard soap the size of a hickory nut to the pailful will usually serve the purpose. If not, add more soap. The leaves can then be coated with poison, but if the soap is mixed with the arsenate of lead, the latter collects in lumps like curdled milk.

The plat contained 13 rows, and the plants were treated as follows:—

Row 1 (50 plants) untreated.

Rows 2-8 (850 plants) dipped leaves and roots in soap mixture and then in arsenate of lead 1 lb. in 2 gallons water.

Rows 9 and 10 (100 plants) dipped roots and leaves in arsenate of lead 1 lb. in 2 gallons water.

Rows 11-13 (150 plants) untreated.

Owing to the lateness of the season these plants were not troubled by maggot, and Mr. Frisbie harvested over 500 marketable cabbage heads. None of these plants were injured by the treatment.

On May 25th, 500 cabbage plants were set on land leased by the station at Mt. Carmel, one-half the plants being dipped in the mixture of soap and arsenate of lead, the latter at the rate

of one pound in two gallons of water. Later some cauliflower and more cabbage plants were set, and likewise tomato. Some of these were dipped, and others left untreated for checks. Some of the tomatoes were injured by the mixture, especially those set during the drought. In no case did the cabbage or cauliflower plants show injury.

Our experience indicates that this treatment will not wholly prevent injury by cutworms, inasmuch as some eating must be done before the cutworm can get the poison. A few cabbage plants at Mt. Carmel were injured by the maggot, and these were in the check rows. Still more tests must be made, and earlier in the season, before the practice can be recommended as a remedy against the cabbage maggot.

The Spruce Gall Louse. For several years Norway spruce trees growing in New Haven have exhibited in early summer curious formations or galls about three-fourths of an inch long and half an inch thick near the ends of the branches at the base of the season's growth. (See Plate XVI.) On examining these galls, we find an opening in the axil of each leaf. These openings are closed on account of the turgid or swollen condition of the tissues, but by bending the twig they can be opened, and small lice-like insects appear inside. There are two broods each year, the nymphs passing the winter at the base of the buds, and becoming mature during the latter part of April. About May 1st the females lay eggs and die. The eggs hatch in about a week, and the nymphs settle at the base of the new shoots, where the galls are formed. After molting three times, the insects develop winged females which emerge through the openings in the galls, and about the middle of August lay eggs covered with a woolly secretion near the tip of a leaf. These eggs hatch in two weeks, and the nymphs are found scattered about over the branches and leaves, until they seek the base of the buds to pass the winter.

This insect has long been known in Europe, but in this country was thought to be a different species, and was first mentioned by Packard* and described provisionally by Thomas†

* Guide to the Study of Insects, p. 523, 1869.

† Eighth Report on Insects of Illinois, p. 156. 1877.

as *Chermes abieticolens*. In Packard's report on forest insects* issued in 1890, this insect is included under the name of *Adelges abieticolens*, Thomas' *Adelges* being a synonym of *Chermes*.

Professor C. H. Fernald, of the Massachusetts Agricultural College, and his assistant, R. A. Cooley, have published† one of the best accounts of this insect which has yet appeared in this country. In order to settle the question of identity, material was submitted to Dr. N. A. Cholodkowski of St. Petersburg, Russia, an authority on this group of insects. From a careful study of material he decided that our species is identical with the European, *C. abietis* Linn. and Thomas' name, therefore, becomes a synonym.

The insect is known to attack Norway, black, white and blue spruces, and the hemlock.

Lochhead‡ and Hopkins§ mentioned the occurrence of this insect in Canada and in West Virginia. Hunter, in his list of the *Aphididae* of North America|| adopts Maskell's genus *Chermaphis* for this species, but this has not been followed by Felt¶ and others.

Spraying with kerosene emulsion is the remedy commonly recommended for this insect, but it did not prove effective in Professor Fernald's tests in Massachusetts. One pound of whale oil soap dissolved in two gallons of water and sprayed upon the trees in April proved a satisfactory remedy. It is doubtful if any spray would reach the insects in early summer when they are inside the galls.

Some writers advise cutting off and burning the galls during June. The common lace-wing *Chrysopa oculata* Say, and the larva of a syrphid fly feed upon the lice.

The Asparagus Miner. On Sept. 20th the asparagus growing on the station grounds was found to be infested by the asparagus miner *Agromyza simplex* Loew. Nearly every stem showed the tunnels. The larva tunnels in the stem near the base and just under the epidermis, working below the surface

* Fifth Report U. S. Entomological Commission, p. 853.

† Report of Mass. Agricultural College, 1898.

‡ Report Ontario Entomological Society, p. 60. 1890.

§ Bulletin 17, N. S. Bureau of Entomology, p. 46, 1898.

|| Bulletin 60, Iowa Agr. Expt. Station, p. 75, 1901.

¶ Insects Affecting Park and Woodland Trees, p. 189. 1905.

of the ground for three or four inches, though sometimes starting several inches or a foot above the ground and working downward. Several larvae are often found in the same stem, sometimes girdling it. The appearance of the infested stems is shown in Fig. 13.

The adult is a small two-winged fly, and the larva can properly be called a maggot. It is not known just how the eggs are laid, but some of the mines start beneath leaf-scales, and as the adult flies are found during the first week in June, the eggs must be deposited at that time. There are two broods each



FIG. 13. Work of asparagus miner at base of stem.

season. The pupa stage resembles a flax seed, is always formed in the mines, and the winter is passed in this condition.

It is not certain just how much damage is done by this insect, but the plants are undoubtedly weakened by the attack. It was noticed on the station grounds that the plants which first turned yellow and died were those most seriously attacked. There is little chance to use insecticides in combating this insect, and we can only recommend pulling and burning the infested stalks as soon as they have been killed by frost in autumn. According to Mr. Edmund Halladay this insect has been observed in Suffield and in Massachusetts by Mr. A. D. Shamel of the

U. S. Department of Agriculture. A bulletin by Sirrine,* who has studied this insect on Long Island, is the best account yet published, and from it some of the facts here given were taken.

Sawfly Larvae Defoliating Peach. In June, Mr. Barnes of Yalesville reported that insects were at work in his peach orchard, and that the leaves had been eaten the previous year. Mr. Walden visited the orchard, and found a number of sawflies in the trees, which had apparently deposited eggs on the undersides of the leaves near the base of the midveins. Some had hatched, and were eating the leaves. The larvae devoured a narrow section from the edge nearly to the midvein, then rolled one of the free corners inward, making a case in which they remained. A later visit showed some trees quite badly defoliated. The adults were submitted to Dr. A. D. MacGillivray, who pronounced it a new species belonging to the genus *Lyda*. Dr. MacGillivray will soon describe and name this insect.

European Grain Moth in Connecticut. Mr. Walden visited the seed storehouses of the Everett B. Clark Company in Milford on August 3d to examine some grain which had become infested with weevils, and to give advice about fumigating the storehouses to destroy them. While several granary pests were present, the chief one seemed to be distinct from anything heretofore observed in this state. On rearing the adult moths, they proved to be the European grain moth *Tinea granella* Linn., a species not before known to occur in Connecticut, though listed from New Jersey. Dr. Howard writes that it is now known to occur in Canada and Michigan, and is probably distributed throughout the Northwestern States.

Mite on Chestnut Leaves. Samples of chestnut leaves were received from Meriden and from Marbledale during the latter part of August, which had been attacked by a mite. The upper surface of the leaves had been injured, and the leaves had turned brown as if scorched. The remains of numerous egg shells were to be seen, as well as living mites, upon the

* Bulletin 189, New York Agr. Expt. Station, 1900.

leaves. The same trouble was found on chestnut trees growing on and near the station grounds. Samples were sent to the Bureau of Entomology, and the pest identified as *Tetranychus bicolor* Banks.

A Sawfly Larva Eating Cherry Leaves. Some injured cherry leaves from New Britain were received August 4th, with a single dead larva in the box. It was an unfamiliar insect, though the same species was received from Harwinton on August 16th, 1902. On examining the cherry trees at the station, we found a few larva on the leaves, but they were not as abundant as the cherry or pear slug. The species proved to be *Strongylogaster pinguis* Norton. The larva is about one-half inch in length, head black, body dark grey with a light grey stripe along each side.

A Root Borer of Garden Iris. Several larvae were sent to the station June 30th, with the statement that they were taken from iris, where they were boring in the roots, causing them to decay. The writer being unfamiliar with them, submitted them to the Bureau of Entomology, where they were thought to be *Macronoctua onusta* Grote, but could not be identified with certainty unless the adults were reared. As all were dead and preserved in alcohol when received, it was impossible to obtain the adult stage.



a.—Inspecting nursery stock. The infested trees are marked by breaking them, and they are afterwards removed.



b.—An excellent type of fumigating house, Keney Park, Hartford.

INSPECTION AND FUMIGATION OF NURSERY STOCK.

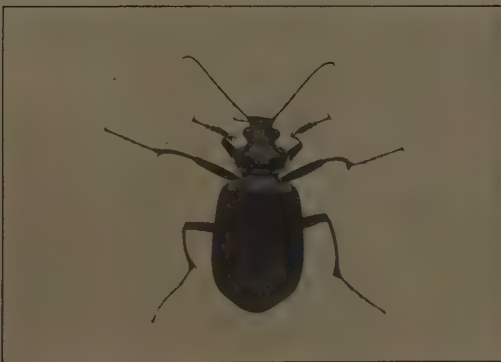




a.—San José Scale on apple bark. Natural size.



b.—Fumigating utensils.



c.—The searcher or caterpillar hunter, *Calosoma scrutator*, natural size.





TREE WHERE FIRST GYPSY MOTH WAS FOUND IN CONNECTICUT.





a.—Brush containing egg-masses.



b.—Different view of same area taken while burning brush.

BRUSH NEAR VELVET MILL WHERE EGG-MASSSES WERE FOUND.



a.—Cutting weeds and sprouts near velvet mill.



b.—Old cemetery which was entirely hidden by brush.

CUTTING BRUSH IN INFESTED AREA.





a.—Burning out a stone wall.



b.—Trees marked and banded.

METHODS OF DESTROYING CATERPILLARS.

(I. E.)

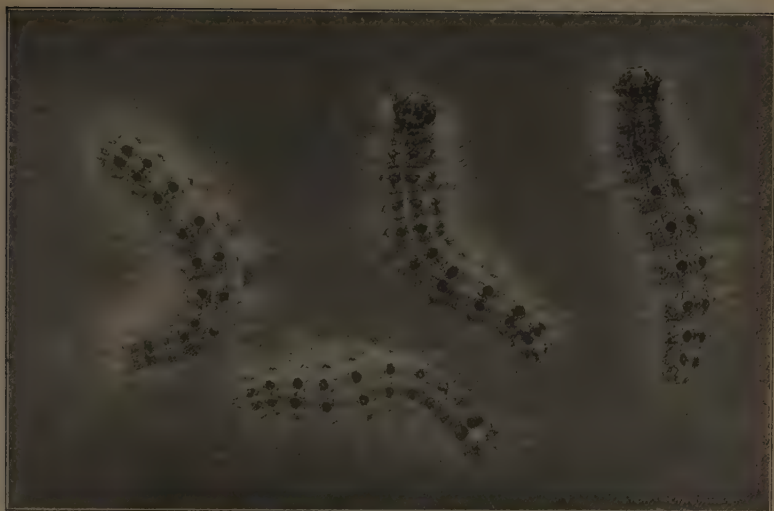


a.—Breeding cage used for obtaining adults.

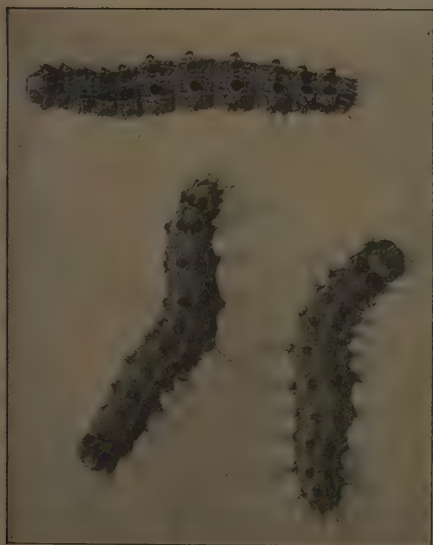


b.—Appearance of tree before and after pruning, scraping and filling cavities.





a.—Caterpillars photographed with black background.



b.—Same caterpillars with light grey background.

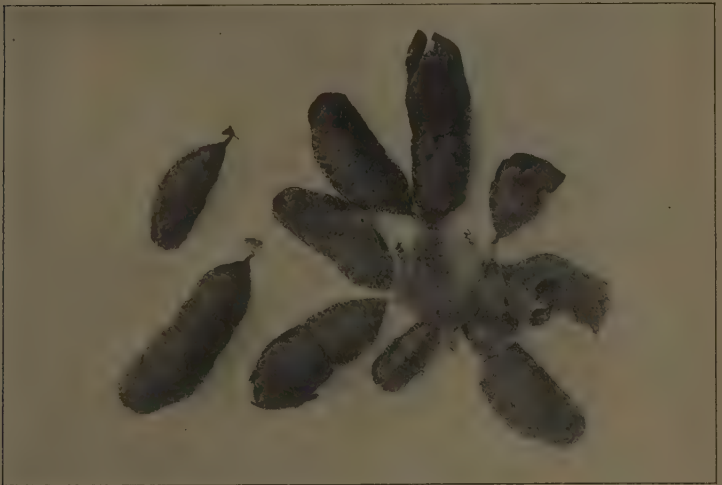


c.—Hatched egg-mass showing holes where young caterpillars have emerged.





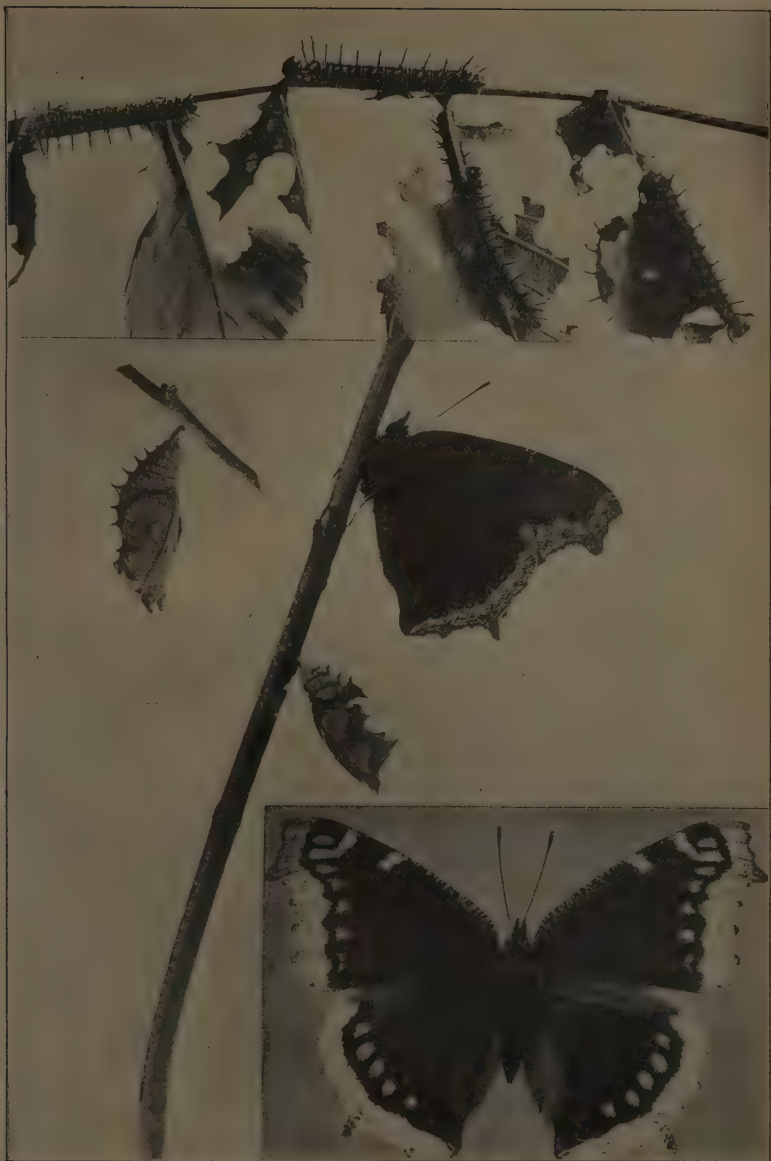
a.—Female moths laying eggs on bark.



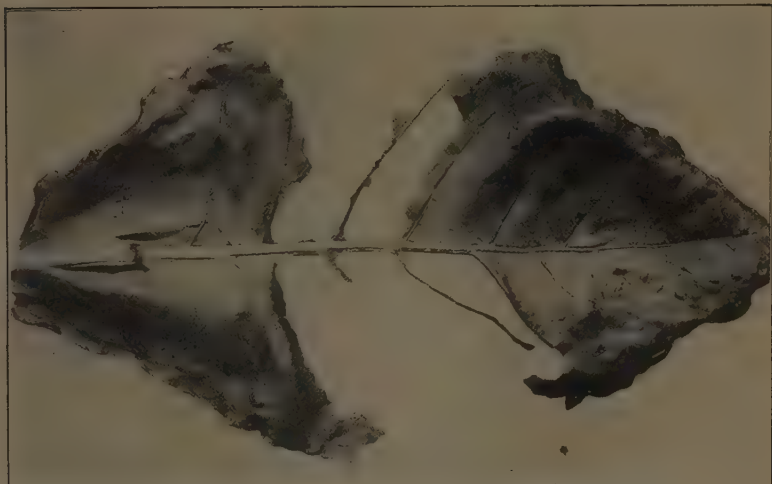
b.—Pupae of gypsy moth.



GYPSY MOTH FEMALES AND MALES SHOWING VARIATION. Natural size.



THE SPINY ELM CATERPILLAR OR MOURNING CLOAK BUTTERFLY.
CATERPILLARS, CHRYSALIS AND ADULTS. Natural size.



a.—Leaf eaten by tobacco worms.

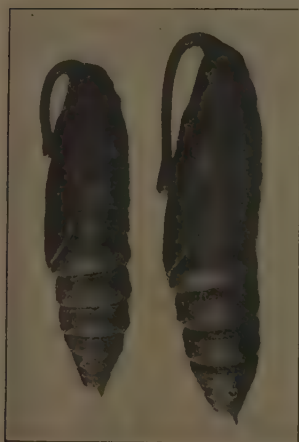


b.—Tobacco worms. Natural size.

TOBACCO WORMS AND LEAF PARTIALLY DEVoured.



a.—Southern tobacco worm on tomato.



b.—Pupae of both species showing difference in length of tongue cases. Northern species at the right.



c.—Young tobacco worm bearing cocoons of parasite.



a.—Southern tobacco worm moth *Phlegethontius sexta* Johan.



b.—Moth of Northern tobacco worm *Phlegethontius quinquemaculata* Haw.

TOBACCO WORM MOTHS. Natural size.



a.—Lower tobacco leaves injured by flea-beetles.



b.—Moth of the black cutworm. Natural size.



c.—The variegated cutworm.
Natural size.

TOBACCO CUTWORMS AND WORK OF FLEA-BEETLES.



a.—Adults and pupa skins of white-fly on tobacco leaf. Enlarged four times.



b.—Work of spruce gall louse. Natural size.

WHITE FLY AND SPRUCE GALL LOUSE.



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